



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

Request For Bids For Construction Services

Two-Stage Bidding Process

Stage II – Mechanical Contractor's Bidders List Invitation to Bid

December 5, 2005

CHILLER REPLACEMENT BUSINESS BUILDING SALT LAKE COMMUNITY COLLEGE REDWOOD ROAD CAMPUS SALT LAKE CITY, UTAH

DFCM Project No. 05238660

Spectrum Engineers
175 South Main Street, Suite 300
Salt Lake City, Utah 84111
(801) 328-5151

TABLE OF CONTENTS

	<u>Page Number</u>
Title Sheet	1
Table of Contents	2
Invitation to Bid	3
Stage II - Bidding Process	4
Stage II - Project Schedule	9
Bid Form	10
Bid Bond Form	12
Contractors Sublist Form	13
Fugitive Dust Plan	16
Contractor's Agreement	23
Performance Bond	28
Payment Bond	29
Change Order Form	30
Certificate of Substantial Completion	31

Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov> or are available upon request from DFCM:

DFCM General Conditions dated May 25, 2005

DFCM Application and Certificate for Payment dated May 25, 2005

Technical Specifications:

Drawings:

The Agreement and General Conditions dated May 25, 2005 have been updated from versions that were formally adopted and in use prior to this date. The changes made to the General Conditions are identified in a document entitled Revisions to General Conditions that is available on DFCM's web site at <http://dfcm.utah.gov>

INVITATION TO BID

**ONLY CONTRACTORS PREVIOUSLY SHORT-LISTED DURING STAGE I
ARE ALLOWED TO BID ON THIS PROJECT**

The State of Utah - Division of Facilities Construction and Management (DFCM) is requesting bids for the construction of the following project:

CHILLER REPLACEMENT - BUSINESS BUILDING
SALT LAKE COMMUNITY COLLEGE - REDWOOD ROAD CAMPUS
SALT LAKE CITY, UTAH
DFCM PROJECT NO: 05238660

Project Description: This project is to replace the chiller in the Business Building on campus. The chiller will be installed in a new location away from the Business Building and connected into the existing chilled water loop. The work requires the demolition of existing screen walls and a concrete floor. A new space will be constructed on existing footing and foundations for the new chiller. Extension of electrical to serve the space is required. Provide a new 550-ton chiller and connect into the existing chilled water and condenser water piping system. Construction cost estimate: \$465,500.

<u>FIRM NAME</u>	<u>POINT OF CONTACT</u>	<u>PHONE</u>	<u>FAX</u>
A.H. Palmer	Mr. Val Palmer	(435) 752-4814	(435) 752-6991
Alternative Mechanical Cont	Mr. Ron White	(801) 261-8523	(801) 261-8561
Barclay Mechanical	Mr. Mike Barclay	(435) 835-5084	(435) 835-5085
KOH Mechanical Contractors	Mr. Larry Hansen	(801) 254-7013	(801) 254-6374
Mechanical Service and Systems	Mr. Randy Karren	(801) 255-9333	(801) 561-4673
Palmer-Christiansen Company Inc	Mr. Brett Christiansen	(801) 466-1679	(801) 466-1777
Ralph Tye and Sons, Inc	Mr. Doug Tye	(801) 262-9900	(801) 262-1391
S.R. Mechanical, Inc.	Mr. Steven Roberts	(435) 529-7492	(435) 529-7851
U.S. Mechanical, LLC	Mr. Brad Bylund	(801) 785-6028	(801) 785-6029

The bid documents will be available at 10:00 AM on Monday, December 5, 2005 in electronic format from DFCM at 4110 State Office Building, Salt Lake City, Utah 84114, telephone (801)538-3018 and on the DFCM web page at <http://dfcm.utah.gov>. For questions regarding this project, please contact Craig Wessman, Project Manager, DFCM, at (801) 538-3246. No others are to be contacted regarding this project.

A **MANDATORY** pre-bid meeting and site visit will be held at 11:00 AM on Friday, December 9, 2005 at the Salt Lake Community College - Redwood Road Campus, 4600 Redwood Road, Taylorsville, Utah. Meet at the Construction Trades Building, Room CT202. All short listed prime contractors wishing to bid on this project must attend this meeting.

Bids must be submitted by 3:00 PM on Tuesday, December 20, 2005 to DFCM, 4110 State Office Building, Salt Lake City, Utah 84114. Bids will be opened and read aloud in the DFCM Conference Room, 4110 State Office Building, Salt Lake City, Utah. Note: Bids must be received at 4110 State Office Building by the specified time. The contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah. A bid bond in the amount of five percent (5%) of the bid amount, made payable to the Division of Facilities Construction and Management on DFCM's bid bond form, shall accompany the bid. The Division of Facilities Construction & Management reserves the right to reject any or all bids or to waive any formality or technicality in any bid in the interest of the State.

DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT
MARLA WORKMAN, CONTRACT COORDINATOR
4110 State Office Bldg., Salt Lake City, Utah 84114

STAGE II BIDDING PROCESS

ONLY CONTRACTORS PREVIOUSLY SHORT-LISTED DURING STAGE I ARE ALLOWED TO BID ON THIS PROJECT

1. Invitational Bid Procedures

Invitation to Bid: DFCM will notify each short-listed firm via e-mail and/or fax when a project is ready for construction services.

Bid Documents: Bidding documents including plans and specifications (if applicable) may be obtained by accessing DFCM's web page at <http://dfcm.utah.gov> or at DFCM's office 4110 State Office Building, Salt Lake City, Utah 84114.

Mandatory Pre-Bid Site Meeting: If required, the schedule contained in this document will indicate the date, time, and place of the mandatory pre-bid site meeting. At this meeting, contractors will receive additional instructions about the project and have an opportunity to ask questions about project details. If a firm fails to attend a pre-bid site meeting labeled "Mandatory" they will not be allowed to bid on the project.

Written Questions: The schedule contained in this document will indicate the deadline for submitting questions in writing to the DFCM Representative pertaining to this project.

Final Addendum: The schedule contained in this document will indicate the deadline for DFCM issuing the final addendum clarifying questions and changes to the scope of work. Contractors are responsible for obtaining and responding to information contained in the addenda.

Submitting Bids: Bids must be submitted to DFCM, 4110 State Office Building, Salt Lake City, Utah 84114 by the deadline indicated on the schedule contained in this document. Bids submitted after the deadline will not be accepted. Bids will be opened at DFCM on the date, time, and place indicated on the schedule. (Additional information pertaining to bidding is contained later in this document). It is your responsibility to allow for the time needed to park on Capitol Hill as recent construction activity has made the parking more difficult. Identification is required to enter the building.

Subcontractors List: The firm selected for the project must submit a list of all subcontractors by the deadline indicated on the schedule contained in this document. (Additional information pertaining to subcontractor lists is contained later in this document)

2. Drawings and Specifications, Other Contract Documents

Drawings and Specifications, as well as other available Contract Documents, may be obtained as stated in the Notice to Contractors.

3. **Bids**

Before submitting a bid, each bidder shall carefully examine the Contract Documents; shall visit the site of the Work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the bid the cost of all items required by the Contract Documents. If the bidder observes that portions of the Contract Documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the bidder shall promptly notify the DFCM Representative and the necessary changes shall be accomplished by Addendum.

The bid, bearing original signatures, must be typed or handwritten in ink on the Bid Form provided in the procurement documents and submitted in a sealed envelope at the location specified by the Notice to Contractor's prior to the published deadline for the submission of bids.

Bid bond security, in the amount of five percent (5%) of the bid, made payable to the Division of Facilities Construction and Management, shall accompany bid. **THE BID BOND MUST BE ON THE BID BOND FORM PROVIDED IN THE PROCUREMENT DOCUMENTS IN ORDER TO BE CONSIDERED AN ACCEPTABLE BID.**

If the bid bond security is submitted on a bid bond form other than the DFCM's required bid bond form, and the bid security meets all other legal requirements, the bidder will be allowed to provide an acceptable bid bond by the close of business on the next business day following notification by DFCM of submission of a defective bid bond security. **Note: A cashier's check cannot be used as a substitute for a bid bond.**

4. **Contract and Bond**

The Contractor's Agreement will be in the form bound in the specifications. The Contract Time will be as indicated in the bid. The successful bidder, simultaneously with the execution of the Contract Agreement, will be required to furnish a performance bond and a payment bond, both bearing original signatures, upon the forms provided in the procurement documents. The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the Contract Sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for Subcontractors will be specified in the Supplementary General Conditions.

5. **Listing of Subcontractors**

Listing of Subcontractors shall be as summarized in the “Instructions and Subcontractor’s List Form”, which are included as part of these Contract Documents. The subcontractors list shall be delivered to DFCM or faxed to DFCM at (801)538-3677 within 24 hours of the bid opening. Requirements for listing additional subcontractors will be listed in the Contract Documents.

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements is subject to a debarment hearing and may be debarred from consideration for award of contract for a period of up to three years.

6. **Interpretation of Drawings and Specifications**

If any person or entity contemplating submitting a bid is in doubt as to the meaning of any part of the drawings, specifications or other Contract Documents, such person shall submit to the DFCM Representative a request for an interpretation thereof. The person or entity submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made only by Addenda duly issued and a copy of such Addenda will be mailed or delivered to each person or entity receiving a set of documents. Neither DFCM nor A/E will be responsible for any other explanations or interpretations of the proposed documents. A/E shall be deemed to refer to the architect or engineer hired by DFCM as the A/E or Consultant for the Project.

7. **Addenda**

Any Addenda issued during the time of bidding shall become part of the Contract Documents made available to the bidders for the preparation of the bid, shall be covered in the bid, and shall be made a part of the Contract.

8. **Award of Contract**

The Contract will be awarded as soon as possible to the lowest, responsive and responsible bidder, based on the lowest combination of base bid and acceptable prioritized alternates, provided the bid is reasonable, is in the interests of the State of Utah to accept and after applying the Utah Preference Laws in U.C.A. Title 63, Chapter 56. The DFCM reserves the right to waive any technicalities or formalities in any bid or in the bidding. Alternates will be accepted on a prioritized basis with Alternate 1 being highest priority, Alternate 2 having second priority, etc.

9. **DFCM Contractor Performance Rating**

DFCM will evaluate the performance of the Contractor. This evaluation may include comments from the User. The Contractor will have an opportunity to review and comment on the evaluation. Evaluations, including the Contractor's comments, may be considered in future selection in the evaluation of the Contractor's past performance.

10. **Licensure**

The Contractor shall comply with and require all of its Subcontractors to comply with the license laws as required by the State of Utah.

11. **Right to Reject Bids**

DFCM reserves the right to reject any or all Bids.

12. **Time is of the Essence**

The completion deadline for this project is **May 5, 2006**. Failure to meet the completion deadline may result in a poor performance rating from DFCM which may have a negative impact on your firm's ability to obtain future work with the state of Utah and may also result in liquidated damages being assessed. Time is of the essence in regard to all the requirements of the Contract Documents.

13. **Withdrawal of Bids**

Bids may be withdrawn on written request received from bidders within 24 hours after the bid opening if the contractor has made an error in preparing the bid.

14. **Product Approvals**

Where reference is made to one or more proprietary products in the Contract Documents, but restrictive descriptive materials of one or more manufacturer(s) is referred to in the Contract Documents, the products of other manufacturers will be accepted, provided they equal or exceed

the standards set forth in the drawings and specifications and are compatible with the intent and purpose of the design, subject to the written approval of the A/E. Such written approval must occur prior to the deadline established for the last scheduled addenda to be issued. The A/E's written approval will be in an issued Addendum. If the descriptive material is not restrictive, the products of other manufacturers specified will be accepted without prior approval provided they are compatible with the intent and purpose of the design as determined by the A/E.

15. **Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors**

Contractors shall respond promptly to any inquiry in writing by the DFCM to any concern of financial responsibility of the Contractor, Subcontractor or Sub-subcontractor.

16. **Debarment.**

By submitting a bid, the Contractor certifies that neither it nor its principals, including project and site managers, have been, or are under consideration for, debarment or suspension, or any action that would exclude such from participation in a construction contract by any governmental department or agency. If the Contractor cannot certify this statement, attach to the bid a detailed written explanation which must be reviewed and approved by the DFCM as part of the requirements for award of the Project.

**Division of Facilities Construction and Management**

PROJECT SCHEDULE

Stage II = Two-Stage Bidding Process

PROJECT NAME: CHILLER REPLACEMENT - BUSINESS BUILDING
SALT LAKE COMMUNITY COLLEGE – REDWOOD ROAD CAMPUS
SALT LAKE CITY, UTAH
DFCM PROJECT #: 05238660

Event	Day	Date	Time	Place
Stage II Bidding Documents Available	Monday	December 5, 2005	10:00 AM	DFCM, 4110 State Office Bldg, SLC, UT and DFCM web site *
Mandatory Pre-bid Site Meeting	Friday	December 9, 2005	11:00 AM	Construction Trades Bldg. Room CT202 ** Salt Lake Community College Redwood Road Campus
Last Day to Submit Questions	Wednesday	December 14, 2005	4:00 PM	DFCM, 4110 State Office Bldg, SLC, UT
Final Addendum Issued	Friday	December 16, 2005	12:00 NOON	DFCM, 4110 State Office Bldg, SLC, UT or DFCM web site*
Prime Contractors Turn in Bid and Bid Bond / Bid Opening in DFCM Conference Room	Tuesday	December 20, 2005	3:00 PM	DFCM, 4110 State Office Bldg, SLC, UT
Subcontractors List Due	Wednesday	December 21, 2005	3:00 PM	DFCM, 4110 State Office Bldg, SLC, UT
Project Completion Date	Friday	May 5, 2006		

* DFCM's web site address is <http://dfcm.utah.gov>

** The Construction Trades Building is located in the southeast corner of Salt Lake Community College - Redwood Road Campus, 4600 South Redwood Road, Taylorsville, Utah. Room CT202 is on the second floor, northeast corner of the building. Parking may be difficult at this time, so allow extra time to find a parking spot. There are meters located in the lot east of the building; otherwise plan on using a visitor parking area.



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

BID FORM

NAME OF BIDDER _____ DATE _____

To the Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

The undersigned, responsive to the "Notice to Contractors" and in accordance with the Request for Bids for the **CHILLER REPLACEMENT - BUSINESS BUILDING - SALT LAKE COMMUNITY COLLEGE - REDWOOD ROAD CAMPUS – SALT LAKE CITY, UTAH - DFCM PROJECT NO. 05238660** and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: _____

BASE BID: For all work shown on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the sum of:

_____ DOLLARS (\$_____) (In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO. 1: To remove the existing chiller and cooling tower at the Business Building, remove concrete, and provide landscaping, I/we agree to perform for the sum of:

_____ DOLLARS (\$_____) (In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO. 2: To remove the existing face brick on the west enclosure and replace with new face brick and extend the height, I/we agree to perform for the sum of:

_____ DOLLARS (\$_____) (In case of discrepancy, written amount shall govern)

BID FORM
PAGE NO. 2

I/We guarantee that the Work will be Substantially Complete by **May 5, 2006**, should I/we be the successful bidder, and agree to pay liquidated damages in the amount of **\$125.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor's Agreement.

This bid shall be good for 45 days after bid opening.

Enclosed is a 5% bid bond, as required, in the sum of _____

The undersigned Contractor's License Number for Utah is _____.

Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract. The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within time set forth.

Type of Organization: _____ (Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws: _____

Respectfully submitted,

Name of Bidder

ADDRESS:

Authorized Signature

BID BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed, (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the STATE OF UTAH, hereinafter referred to as the "Obligee," in the amount of \$ _____ (5% of the accompanying bid), being the sum of this Bond to which payment the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted to Obligee the accompanying bid incorporated by reference herein, dated as shown, to enter into a contract in writing for the _____ Project.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that if the said principal does not execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the principal, then the sum of the amount stated above will be forfeited to the State of Utah as liquidated damages and not as a penalty; if the said principal shall execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the Principal, then this obligation shall be null and void. It is expressly understood and agreed that the liability of the Surety for any and all defaults of the Principal hereunder shall be the full penal sum of this Bond. The Surety, for value received, hereby stipulates and agrees that obligations of the Surety under this Bond shall be for a term of sixty (60) days from actual date of the bid opening.

PROVIDED, HOWEVER, that this Bond is executed pursuant to provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals on the date indicated below, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

DATED this _____ day of _____, 20_____.

Principal's name and address (if other than a corporation):

By: _____

Title: _____

Principal's name and address (if a corporation):

By: _____

Title: _____
(Affix Corporate Seal)

Surety's name and address:

STATE OF _____)
COUNTY OF _____) ss.

By: _____
Attorney-in-Fact (Affix Corporate Seal)

On this ____ day of _____, 20_____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20_____.

My Commission Expires: _____

Resides at: _____

Agency: _____
Agent: _____
Address: _____
Phone: _____

NOTARY PUBLIC

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

**Division of Facilities Construction and Management****INSTRUCTION AND SUBCONTRACTORS LIST FORM**

The three low bidders, as well as all other bidders that desire to be considered, are required by law to submit to DFCM within 24 hours of bid opening a list of **ALL** first-tier subcontractors, including the subcontractor's name, bid amount and other information required by Building Board Rule and as stated in these Contract Documents, on the following basis:

PROJECTS UNDER \$500,000 - ALL SUBS \$20,000 OR OVER MUST BE LISTED
PROJECTS \$500,000 OR MORE - ALL SUBS \$35,000 OR OVER MUST BE LISTED

- Any additional subcontractors identified in the bid documents shall also be listed.
- The DFCM Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law.
- List subcontractors for base bid as well as the impact on the list that the selection of any alternate may have.
- Bidder may not list more than one subcontractor to perform the same work.
- Bidder must list "Self" if performing work itself.

LICENSURE:

The subcontractor's name, the type of work, the subcontractor's bid amount, and the subcontractor's license number as issued by DOPL, if such license is required under Utah Law, shall be listed. Bidder shall certify that all subcontractors, required to be licensed, are licensed as required by State law. A subcontractor includes a trade contractor or specialty contractor and does not include suppliers who provide only materials, equipment, or supplies to a contractor or subcontractor.

BIDDER LISTING 'SELF' AS PERFORMING THE WORK:

Any bidder that is properly licensed for the particular work and intends to perform that work itself in lieu of a subcontractor that would otherwise be required to be on the subcontractor list, must insert the term 'Self' for that category on the subcontractor list form. Any listing of 'Self' on the sublist form shall also include the amount allocated for that work.

'SPECIAL EXCEPTION':

A bidder may list 'Special Exception' in place of a subcontractor when the bidder intends to obtain a subcontractor to perform the work at a later date because the bidder was unable to obtain a qualified or reasonable bid under the provisions of U.C.A. Section 63A-5-208(4). The bidder shall insert the term 'Special Exception' for that category of work, and shall provide documentation with the subcontractor list describing the bidder's efforts to obtain a bid of a qualified subcontractor at a reasonable cost and why the bidder was unable to obtain a qualified subcontractor bid. The Director must find that the bidder complied in good faith with State law requirements for any 'Special Exception' designation, in order for the bid to be considered. If awarded the contract, the Director shall supervise the bidder's efforts to obtain a qualified subcontractor bid. The amount of the awarded contract may not be adjusted to reflect the actual amount of the subcontractor's bid. Any listing of 'Special Exception' on the sublist form shall also include amount allocated for that work.

INSTRUCTIONS AND SUBCONTRACTORS LIST FORM
Page No. 2

GROUND FOR DISQUALIFICATION:

The Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law. Director may withhold awarding the contract to a particular bidder if one or more of the proposed subcontractors are considered by the Director to be unqualified to do the Work or for such other reason in the best interest of the State of Utah. Notwithstanding any other provision in these instructions, if there is a good faith error on the sublist form, at the sole discretion of the Director, the Director may provide notice to the contractor and the contractor shall have 24 hours to submit the correction to the Director. If such correction is submitted timely, then the sublist requirements shall be considered met.

CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:

Subsequent to twenty-four hours after the bid opening, the contractor may change its listed subcontractors only after receiving written permission from the Director based on complying with all of the following criteria.

- (1) The contractor has established in writing that the change is in the best interest of the State and that the contractor establishes an appropriate reason for the change, which may include, but not is not limited to, the following reasons: the original subcontractor has failed to perform, or is not qualified or capable of performing, and/or the subcontractor has requested in writing to be released.
- (2) The circumstances related to the request for the change do not indicate any bad faith in the original listing of the subcontractors.
- (3) Any requirement set forth by the Director to ensure that the process used to select a new subcontractor does not give rise to bid shopping.
- (4) Any increase in the cost of the subject subcontractor work is borne by the contractor.
- (5) Any decrease in the cost of the subject subcontractor work shall result in a deductive change order being issued for the contract for such decreased amount.
- (6) The Director will give substantial weight to whether the subcontractor has consented in writing to being removed unless the Contractor establishes that the subcontractor is not qualified for the work.

EXAMPLE:

Example of a list where there are only four subcontractors:

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONT. LICENSE #
ELECTRICAL	ABCD Electric Inc.	\$350,000.00	123456789000
LANDSCAPING	"Self"	300,000.00	123456789000
CONCRETE (ALTERNATE #1)	XYZ Concrete Inc	298,000.00	987654321000
MECHANICAL	"Special Exception" (attach documentation)	Fixed at: 350,000.00	(TO BE PROVIDED AFTER OBTAINING SUBCONTRACTOR)

**PURSUANT TO STATE LAW - SUBCONTRACTOR BID AMOUNTS CONTAINED IN THIS
SUBCONTRACTOR LIST SHALL NOT BE DISCLOSED UNTIL THE CONTRACT HAS BEEN AWARDED.**

**Division of Facilities Construction and Management****SUBCONTRACTORS LIST****PROJECT TITLE:** _____**Caution:** You must read and comply fully with instructions.

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONT. LICENSE #

We certify that:

1. This list includes all subcontractors as required by the instructions, including those related to the base bid as well as any alternates.
2. We have listed "Self" or "Special Exception" in accordance with the instructions.
3. All subcontractors are appropriately licensed as required by State law.

FIRM: _____

DATE: _____

SIGNED BY: _____

NOTICE: FAILURE TO SUBMIT THIS FORM, PROPERLY COMPLETED AND SIGNED, AS REQUIRED IN THESE CONTRACT DOCUMENTS, SHALL BE GROUNDS FOR DFCMS REFUSAL TO ENTER INTO A WRITTEN CONTRACT WITH BIDDER. ACTION MAY BE TAKEN AGAINST BIDDERS BID BOND AS DEEMED APPROPRIATE BY DFCM. ATTACH A SECOND PAGE IF NECESSARY.

FUGITIVE DUST PLAN

The Contractor will fill out the form and file the original with the Division of Air Quality and a copy of the form with the Division of Facilities Construction & Management, prior to the issuance of any notice to proceed.

The Contractor will be fully responsible for compliance with the Fugitive Dust Control Plan, including the adequacy of the plan, any damages, fines, liability, and penalty or other action that results from noncompliance.

Utah Division of Air Quality

April 20, 1999

**GUIDANCE THAT MUST BE CONSIDERED IN DEVELOPING AND SUBMITTING A
DUST CONTROL PLAN FOR COMPLIANCE WITH R307-309-3, 4, 5, 6, 7**

Source Information:

1. Name of your operation (source): provide a name if the source is a construction site.
2. Address or location of your operation or construction site.
3. UTM coordinates or Longitude/Latitude of stationary emission points at your operation.
4. Lengths of the project, if temporary (time period).
5. Description of process (include all sources of dust and fugitive dust). Please, if necessary, use additional sheets of paper for this description. Be sure to mark it as an attachment.
6. Type of material processed or disturbed.
7. Amount of material processed (tons per year, tons per month, lbs./hr., and applicable units).

8. Destination of product (where will the material produced be used or transported, be specific, provide address or specific location), information needed for temporary relocation applicants.

9. Identify the individual who is responsible for the implementation and maintenance of fugitive dust control measures. List name(s), position(s) and telephone number(s).

10. List, and attach copies of any contract lease, liability agreement with other companies that may, or will, be responsible for dust control on site or on the project.

Description of Fugitive Dust Emission Activities
(Things to consider in addressing fugitive dust control strategies.)

1. Type of activities (drilling and blasting, road construction, development construction, earth moving and excavation, handling and hauling materials, cleaning and leveling, etc).
2. List type of equipment generating the fugitive dust.
3. Diagram the location of each activity or piece of equipment on site. Please attach the diagram.
4. Provide pictures or drawings of each activity. Include a drawing of the unpaved/paved road network used to move loads “on” and “off” property.
5. Vehicle miles travels on unpaved roads associated with the activity (average speed).
6. Type of dust emitted at each source (coal, cement, sand, soil, clay, dust, etc.)
7. Estimate the size of the release area at which the activity occurs (square miles). For haul or dirt roads include total miles of road in use during the activity.

Description of Fugitive Dust Emission Controls on Site

Control strategies must be designed to meet 20% opacity or less on site (a lesser opacity may be defined by Approval Order conditions or federal requirements such as NSPS), and control strategies must prevent exceeding 10% opacity from fugitive dust at the property boundary (site boundary) for compliance with R307-309-3.

1. Types of ongoing emission controls proposed for each activity, each piece of equipment, and haul roads.
2. Types of additional dust controls proposed for bare, exposed surfaces (chemical stabilization, synthetic cover, wind breaks, vegetative cover, etc).
3. Method of application of dust suppressant.
4. Frequency of application of dust suppressant.
5. Explain what triggers the use of a special control measure other than routine measures already in place, such as covered loads or measures covered by a permit condition (increase in opacity, high winds, citizen complaints, dry conditions, etc).
6. Explain in detail what control strategies/measures will be implemented off-hours, i.e., Saturdays/Sundays/Holidays, as well as 6 PM to 6 AM each day.

Description of Fugitive Dust Control Off-site

Prevent, to the maximum extent possible, deposition of materials, which may create fugitive dust on public and private paved roads in compliance with R307-309-5, 6, 7.

1. Types of emission controls initiated by your operation that are in place “off” property (application of water, covered loads, sweeping roads, vehicle cleaning, etc.).

2. Proposed remedial controls that will be initiated promptly if materials, which may create fugitive dust, are deposited on public and private paved roads.

Submit the Dust Control Plan to:

Executive Secretary
Utah Air Quality Board
POB 144820
15 North 1950 West
Salt Lake City, Utah 84114-4820

Phone: (801) 536-4000
FAX: (801) 536-4099

Fugitive Dust Control Plan Violation Report

When a source is found in violation of R307-309-3 or in violation of the Fugitive Dust Control Plan, the source must submit a report to the Executive Secretary within 15 days after receiving a Notice of Violation. The report must include the following information:

1. Name and address of dust source.
2. Time and duration of dust episode.
3. Meteorological conditions during the dust episode.
4. Total number and type of fugitive dust activities and dust producing equipment within each operation boundary. If no change has occurred from the existing dust control plan, the source should state that the activity/equipment is the same.
5. Fugitive dust activities or dust producing equipment that caused a violation of R-307-309-3 or the source's dust control plan.
6. Reasons for failing to control dust from the dust generating activity or equipment.
7. New and/or additional fugitive dust control strategies necessary to achieve compliance with R307-309-3, 4, 5, 6, or 7.
8. If it can not be demonstrated that the current approved Dust Control Plan can result in compliance with R307-309-3 through 7, the Dust Control Plan must be revised so as to demonstrate compliance with 307-309-3 through 7. Within 30 days of receiving a fugitive dust Notice of Violation, the source must submit the revised Plan to the Executive Secretary for review and approval.

Submit the Dust Control Plan to:

Executive Secretary	Phone: (801) 536-4000
Utah Air Quality Board	FAX: (801) 536-4099
POB 144820	
15 North 1950 West	
Salt Lake City, Utah 84114-4820	

Attachments: DFCM Form FDR R-307-309, Rule 307-309

CONTRACTOR'S AGREEMENT

FOR:

THIS CONTRACTOR'S AGREEMENT, made and entered into this ____ day of _____, 20__, by and between the DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT, hereinafter referred to as "DFCM", and _____, incorporated in the State of _____ and authorized to do business in the State of Utah, hereinafter referred to as "Contractor", whose address is _____.

WITNESSETH: WHEREAS, DFCM intends to have Work performed at _____
_____.

WHEREAS, Contractor agrees to perform the Work for the sum stated herein.

NOW, THEREFORE, DFCM and Contractor for the consideration provided in this Contractor's Agreement, agree as follows:

ARTICLE 1. SCOPE OF WORK. The Work to be performed shall be in accordance with the Contract Documents prepared by _____ and entitled "_____
_____."

The DFCM General Conditions ("General Conditions") dated May 25, 2005 on file at the office of DFCM and available on the DFCM website, are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

The Contractor Agrees to furnish labor, materials and equipment to complete the Work as required in the Contract Documents which are hereby incorporated by reference. It is understood and agreed by the parties hereto that all Work shall be performed as required in the Contract Documents and shall be subject to inspection and approval of DFCM or its authorized representative. The relationship of the Contractor to the DFCM hereunder is that of an independent Contractor.

ARTICLE 2. CONTRACT SUM. The DFCM agrees to pay and the Contractor agrees to accept in full performance of this Contractor's Agreement, the sum of _____ DOLLARS AND NO CENTS (\$_____.00), which is the base bid, and which sum also includes the cost of a 100%

CONTRACTOR'S AGREEMENT
PAGE NO. 2

Performance Bond and a 100% Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

ARTICLE 3. TIME OF COMPLETION AND DELAY REMEDY. The Work shall be Substantially Complete within _____ (____) calendar days after the date of the Notice to Proceed. Contractor agrees to pay liquidated damages in the amount of \$_____ per day for each day after expiration of the Contract Time until the Contractor achieves Substantial Completion in accordance with the Contract Documents, if Contractor's delay makes the damages applicable. The provision for liquidated damages is: (a) to compensate the DFCM for delay only; (b) is provided for herein because actual damages can not be readily ascertained at the time of execution of this Contractor's Agreement; (c) is not a penalty; and (d) shall not prevent the DFCM from maintaining Claims for other non-delay damages, such as costs to complete or remedy defective Work.

No action shall be maintained by the Contractor, including its or Subcontractor or suppliers at any tier, against the DFCM or State of Utah for damages or other claims due to losses attributable to hindrances or delays from any cause whatsoever, including acts and omissions of the DFCM or its officers, employees or agents, except as expressly provided in the General Conditions. The Contractor may receive a written extension of time, signed by the DFCM, in which to complete the Work under this Contractor's Agreement in accordance with the General Conditions.

ARTICLE 4. CONTRACT DOCUMENTS. The Contract Documents consist of this Contractor's Agreement, the Conditions of the Contract (DFCM General Conditions, Supplementary and other Conditions), the Drawings, Specifications, Addenda and Modifications. The Contract Documents shall also include the bidding documents, including the Notice to Contractors, Instructions to Bidders/Proposers and the Bid/Proposal, to the extent not in conflict therewith and other documents and oral presentations that are documented as an attachment to the contract.

All such documents are hereby incorporated by reference herein. Any reference in this Contractor's Agreement to certain provisions of the Contract Documents shall in no way be construed as to lessen the importance or applicability of any other provisions of the Contract Documents.

ARTICLE 5. PAYMENT. The DFCM agrees to pay the Contractor from time to time as the Work progresses, but not more than once each month after the date of Notice to Proceed, and only upon Certificate of the A/E for Work performed during the preceding calendar month, ninety-five percent (95%) of the value of the labor performed and ninety-five percent (95%) of the value of materials furnished in place or on the site. The Contractor agrees to furnish to the DFCM invoices for materials purchased and on the site but not installed, for which the

CONTRACTOR'S AGREEMENT
PAGE NO. 3

Contractor requests payment and agrees to safeguard and protect such equipment or materials and is responsible for safekeeping thereof and if such be stolen, lost or destroyed, to replace same.

Such evidence of labor performed and materials furnished as the DFCM may reasonably require shall be supplied by the Contractor at the time of request for Certificate of Payment on account. Materials for which payment has been made cannot be removed from the job site without DFCM's written approval. Five percent (5%) of the earned amount shall be retained from each monthly payment. The retainage, including any additional retainage imposed and the release of any retainage, shall be in accordance with UCA 13-8-5 as amended. Contractor shall also comply with the requirements of UCA 13-8-5, including restrictions of retainage regarding subcontractors and the distribution of interest earned on the retention proceeds. The DFCM shall not be responsible for enforcing the Contractor's obligations under State law in fulfilling the retention law requirements with subcontractors at any tier.

ARTICLE 6. INDEBTEDNESS. Before final payment is made, the Contractor must submit evidence satisfactory to the DFCM that all payrolls, materials bills, subcontracts at any tier and outstanding indebtedness in connection with the Work have been properly paid. Final Payment will be made after receipt of said evidence, final acceptance of the Work by the DFCM as well as compliance with the applicable provisions of the General Conditions.

Contractor shall respond immediately to any inquiry in writing by DFCM as to any concern of financial responsibility and DFCM reserves the right to request any waivers, releases or bonds from Contractor in regard to any rights of Subcontractors (including suppliers) at any tier or any third parties prior to any payment by DFCM to Contractor.

ARTICLE 7. ADDITIONAL WORK. It is understood and agreed by the parties hereto that no money will be paid to the Contractor for additional labor or materials furnished unless a new contract in writing or a Modification hereof in accordance with the General Conditions and the Contract Documents for such additional labor or materials has been executed. The DFCM specifically reserves the right to modify or amend this Contractor's Agreement and the total sum due hereunder either by enlarging or restricting the scope of the Work.

ARTICLE 8. INSPECTIONS. The Work shall be inspected for acceptance in accordance with the General Conditions.

ARTICLE 9. DISPUTES. Any dispute, PRE or Claim between the parties shall be subject to the provisions of Article 7 of the General Conditions. DFCM reserves all rights to pursue its rights and remedies as provided in the General Conditions.

ARTICLE 10. TERMINATION, SUSPENSION OR ABANDONMENT. This Contractor's Agreement may be terminated, suspended or abandoned in accordance with the General Conditions.

ARTICLE 11. DFCM'S RIGHT TO WITHHOLD CERTAIN AMOUNT AND MAKE USE THEREOF. The DFCM may withhold from payment to the Contractor such amount as, in DFCM's judgment, may be necessary to pay just claims against the Contractor or Subcontractor at any tier for labor and services rendered and materials furnished in and about the Work. The DFCM may apply such withheld amounts for the payment of such claims in DFCM's discretion. In so doing, the DFCM shall be deemed the agent of Contractor and payment so made by the DFCM shall be considered as payment made under this Contractor's Agreement by the DFCM to the Contractor. DFCM shall not be liable to the Contractor for any such payment made in good faith. Such withholdings and payments may be made without prior approval of the Contractor and may be also be prior to any determination as a result of any dispute, PRE, Claim or litigation.

ARTICLE 12. INDEMNIFICATION. The Contractor shall comply with the indemnification provisions of the General Conditions.

ARTICLE 13. SUCCESSORS AND ASSIGNMENT OF CONTRACT. The DFCM and Contractor, respectively bind themselves, their partners, successors, assigns and legal representatives to the other party to this Agreement, and to partners, successors, assigns and legal representatives of such other party with respect to all covenants, provisions, rights and responsibilities of this Contractor's Agreement. The Contractor shall not assign this Contractor's Agreement without the prior written consent of the DFCM, nor shall the Contractor assign any moneys due or to become due as well as any rights under this Contractor's Agreement, without prior written consent of the DFCM.

ARTICLE 14. RELATIONSHIP OF THE PARTIES. The Contractor accepts the relationship of trust and confidence established by this Contractor's Agreement and covenants with the DFCM to cooperate with the DFCM and A/E and use the Contractor's best skill, efforts and judgment in furthering the interest of the DFCM; to furnish efficient business administration and supervision; to make best efforts to furnish at all times an adequate supply of workers and materials; and to perform the Work in the best and most expeditious and economic manner consistent with the interests of the DFCM.

ARTICLE 15. AUTHORITY TO EXECUTE AND PERFORM AGREEMENT. Contractor and DFCM each represent that the execution of this Contractor's Agreement and the performance thereunder is within their respective duly authorized powers.

ARTICLE 16. ATTORNEY FEES AND COSTS. Except as otherwise provided in the dispute resolution provisions of the General Conditions, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in any action in the District Court and/or appellate body to enforce this Contractor's Agreement or recover damages or any other action as a result of a breach thereof.

CONTRACTOR'S AGREEMENT
PAGE NO. 5

IN WITNESS WHEREOF, the parties hereto have executed this Contractor's Agreement on the day and year stated hereinabove.

CONTRACTOR: _____

Signature Date

Title: _____

State of _____)
County of _____)

Please type/print name clearly

On this ____ day of _____, 20____, personally appeared before me, _____, whose identity is personally known to me (or proved to me on the basis of satisfactory evidence) and who by me duly sworn (or affirmed), did say that he (she) is the _____ (title or office) of the firm and that said document was signed by him (her) in behalf of said firm.

(SEAL)

Notary Public

My Commission Expires _____

APPROVED AS TO AVAILABILITY
OF FUNDS:

Financial Manager, Date
Division of Facilities Construction
and Management

**DIVISION OF FACILITIES
CONSTRUCTION AND MANAGEMENT**

Manager - Date
Capital _____

APPROVED AS TO FORM:
ATTORNEY GENERAL
May 25, 2005
By: Alan S. Bachman
Asst Attorney General

APPROVED FOR EXPENDITURE:

Division of Finance Date

PERFORMANCE BOND
(Title 63, Chapter 56, U. C. A. 1953, as Amended)

That _____ hereinafter referred to as the "Principal" and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah, hereinafter referred to as the "Obligee," in the amount of _____ DOLLARS (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____, for the approximate sum of _____ Dollars (\$ _____), which Contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall faithfully perform the Contract in accordance with the Contract Documents including, but not limited to, the Plans, Specifications and conditions thereof, the one year performance warranty, and the terms of the Contract as said Contract may be subject to Modifications or changes, then this obligation shall be void; otherwise it shall remain in full force and effect.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the state named herein or the heirs, executors, administrators or successors of the Owner.

The parties agree that the dispute provisions provided in the Contract Documents apply and shall constitute the sole dispute procedures of the parties.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the Provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____
(Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____
Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney in-fact of the above-named Surety Company and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General
28

PAYMENT BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____ authorized to do business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); with its principal office in the City of _____, hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah hereinafter referred to as the "Obligee," in the amount of _____ Dollars (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____ for the approximate sum of _____ Dollars (\$ _____), which contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall pay all claimants supplying labor or materials to Principal or Principal's Subcontractors in compliance with the provisions of Title 63, Chapter 56, of Utah Code Annotated, 1953, as amended, and in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise it shall remain in full force and effect.

That said Surety to this Bond, for value received, hereby stipulates and agrees that no changes, extensions of time, alterations or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any way affect its obligation on this Bond, and does hereby waive notice of any such changes, extensions of time, alterations or additions to the terms of the Contract or to the Work or to the specifications or drawings and agrees that they shall become part of the Contract Documents.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

**Division of Facilities Construction and Management****CHANGE ORDER # _____**

CONTRACTOR: _____

AGENCY OR INSTITUTION: _____

PROJECT NAME: _____

PROJECT NUMBER: _____

CONTRACT NUMBER: _____

ARCHITECT: _____

DATE: _____

CONSTRUCTION CHANGE DIRECTIVE NO.	PROPOSAL REQUEST NO.	AMOUNT		DAYS	
		INCREASE	DECREASE	INCREASE	DECREASE

	Amount	Days	Date
ORIGINAL CONTRACT			
TOTAL PREVIOUS CHANGE ORDERS			
TOTAL THIS CHANGE ORDER			
ADJUSTED CONTRACT			

DFCM and Contractor agree that the terms, contract sum, scope of the Work and time specified in this Change Order shall constitute the full accord and satisfaction, and complete adjustment to the Contract and includes all direct and indirect costs and effects related to, incidental to, and/or reasonably implied from such change in the contract terms, sum, scope of the Work and time.

Contractor: _____

Date _____

Architect/Engineer: _____

Date _____

Agency or Institution: _____

Date _____

DFCM: _____

Date _____

Funding Verification: _____

Date _____



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management**DFCM****CERTIFICATE OF SUBSTANTIAL COMPLETION**

PROJECT _____ PROJECT NO: _____

AGENCY/INSTITUTION _____

AREA ACCEPTED _____

The Work performed under the subject Contract has been reviewed on this date and found to be Substantially Completed as defined in the General Conditions; including that the construction is sufficiently completed in accordance with the Contract Documents, as modified by any change orders agreed to by the parties, so that the State of Utah can occupy the Project or specified area of the Project for the use for which it is intended.

The DFCM - (Owner) accepts the Project or specified area of the Project as Substantially Complete and will assume full possession of the Project or specified area of the Project at _____ (time) on _____ (date).

The DFCM accepts the Project for occupancy and agrees to assume full responsibility for maintenance and operation, including utilities and insurance, of the Project subject to the itemized responsibilities and/or exceptions noted below:

The Owner acknowledges receipt of the following closeout and transition materials:

☐ Record Drawings ☐ O & M Manuals ☐ Warranty Documents ☐ Completion of Training Requirements

A list of items to be completed or corrected (Punch List) is attached hereto. The failure to include an item on it does not alter the responsibility of the Contractor to complete all the Work in accordance with the Contract Documents, including authorized changes thereof. The amount of _____. (Twice the value of the punch list work) shall be retained to assure the completion of the punch list work.

The Contractor shall complete or correct the Work on the list of (Punch List) items appended hereto within _____ calendar days from the above date of issuance of this Certificate. If the list of items is not completed within the time allotted the Owner has the right to be compensated for the delays and/or complete the work with the help of independent contractor at the expense of the retained project funds. If the retained project funds are insufficient to cover the delay/completion damages, the Owner shall be promptly reimbursed for the balance of the funds needed to compensate the Owner.

CONTRACTOR (include name of firm) by: _____
(Signature) DATE

A/E (include name of firm) by: _____
(Signature) DATE

USING INSTITUTION OR AGENCY by: _____
(Signature) DATE

DFCM (Owner) by: _____
(Signature) DATE

4110 State Office Building, Salt Lake City, Utah 84114
telephone 801-538-3018 • facsimile 801-538-3267 • <http://dfcm.utah.gov>

cc: Parties Noted
DFCM, Director

PROJECT MANUAL

05 December 2005

DFCM #05238660

SLCC BUSINESS BUILDING CHILLER REPLACEMENT Redwood Campus



**Spectrum Engineers
DFCM #05238660**

**BUSINESS BUILDING CHILLER REPLACEMENT
SLCC Redwood Campus**

Spectrum Engineers, Inc.

175 South Main Street, Suite 300
Salt Lake City, Utah 84111

P 801-328-5151

F 801-328-5155

HFS Architects

329 South Rio Grande Street
Salt Lake City, Utah 84101

P 801-596-0691

F 801-596-0693

ES² Engineering Structural Solutions

442 North Main Street
Bountiful, Utah 84010

P 801-298-1118

F 801-298-1122

Thomas & Kolkman Engineering Company, Inc.

64 West 1700 South
Salt Lake City, Utah 84115

P 801-484-8161

F 801-484-3538

SECTION	SECTION TITLE	PAGES
Division 1 - GENERAL REQUIREMENTS		
01100	Summary of Work	3
01230	Alternates	2
01310	Project Management and Coordination	5
01322	Photographic Documentation	2
01330	Submittal Procedures	10
01731	Cutting and Patching	4
01732	Selective Demolition	8
01770	Closeout Procedures	4
01781	Project Record Documents	3
Division 3 - CONCRETE		
03300	Cast-In-Place Concrete	17
03310	Concrete Curing and Sealing	3
Division 4 - MASONRY		
04810	Unit Masonry Assemblies	16
Division 5 - METALS		
05120	Structural Steel	6
05310	Steel Deck	4
05500	Metal Fabrications	8
Division 6 - WOOD AND PLASTICS		
06100	Rough Carpentry	3
Division 7 - THERMAL AND MOISTURE PROTECTION		
07540	Thermoplastic Membrane Roofing	11
07620	Sheet Metal Flashing and Trim	7
07720	Roof Accessories	6
07920	Joint Sealants	7
Division 8 - DOORS AND WINDOWS		
08110	Steel Doors and Frames	9
08710	Door Hardware	14
Division 9 - FINISHES		
09900	Painting	10
Division 15 - MECHANICAL		
15010	Basic Mechanical Requirements	7
15050	Basic Mechanical Materials and Methods	14
15055	Motors	3
15060	Hangers and Supports	8
15071	Mechanical Vibration and Seismic Controls	5
15075	Mechanical Identification	5

Division 15 - MECHANICAL (continued)

15080	Mechanical Insulation	9
15110	Valves	10
15122	Meters and Gages	7
15150	Sanitary Waste and Vent Piping	7
15181	Hydronic Piping	13
15185	Hydronic Pumps	7
15620	Fuel-Fired Heaters	5
15625	Centrifugal Chillers - Water Cooled	19
15763	Fan-Coil Units	6
15825	Terminal Units	6
15838	Power Ventilators	4
15971	Automatic Temperature Controls	13
15990	Testing, Adjusting, and Balancing: O & M Manuals and System Commissioning	13

Division 16 - ELECTRICAL

16000	General Provisions, Electrical	6
16060	Minor Electrical Demolition for Remodeling	3
16110	Raceways	4
16120	Conductors	3
16130	Electrical Boxes	3
16190	Supporting Devices	1
16195	Electrical Identification	2
16400	Secondary Service and Distribution	1
16450	Secondary Grounding	1
16470	Panelboards	2
16480	Motor Starters and Controls	3
16485	Variable Frequency Drives	15
16720	Fire Alarm Systems	4

SECTION 01100 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Work covered by the Contract Documents.
 - 2. Type of the Contract.
 - 3. Use of premises.
 - 4. Owner's occupancy requirements.
 - 5. Work restrictions.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: Business Building Chiller Replacement.
 - 1. Project Location: Salt Lake Community College, Redwood Campus.
- B. Owner: DFCM, 4110 State Office Building, Salt Lake City, Utah 84114.
 - 1. Owner's Representative: Craig Wessman.
- C. Engineer: Spectrum Engineers, 175 South Main Street, Suite 300, Salt Lake City, Utah 84111.
- D. The Work consists of the following:
 - 1. The Work includes demolition and replacement of the existing chiller and the associated electrical work, demolition of existing block and brick screen wall, and construction of a new masonry chiller building.

1.4 TYPE OF CONTRACT

- A. Project will be constructed under a single prime contract.

1.5 USE OF PREMISES

SUMMARY

- A. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.
- B. Use of Site: Limit use of premises to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
 - 1. Limits: Confine constructions operations to the construction limit line shown on the drawings.
 - a. Limit site disturbance, including earthwork and clearing of vegetation, to **40 feet** beyond building perimeter; **5 feet** beyond primary roadway curbs, walkways, and main utility branch trenches; and **25 feet** beyond pervious paving areas.
 - 2. Owner Occupancy: Allow for Owner occupancy of Project site and use by the public.
 - 3. Driveways and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

1.6 OWNER'S OCCUPANCY REQUIREMENTS

- A. Full Owner Occupancy: Owner will occupy site and adjacent building during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits, unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 - 2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.7 WORK RESTRICTIONS

- A. On-Site Work Hours: Work shall be generally performed inside the existing building during normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday, except otherwise indicated.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than three days in advance of proposed utility interruptions.

1.8 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
 1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
 2. Division 1: Sections in Division 1 govern the execution of the Work of all Sections in the Specifications.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

1.9 MISCELLANEOUS PROVISIONS

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01100

SECTION 01230 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A Schedule of Alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: To remove the existing Business Building chiller and associated abandoned piping, equipment and electrical.
- B. Alternate No. 2: Remove the existing brick veneer on the west wall of the Generator Enclosure, extend the wall to the height of the new wall and re-skin with new brick veneer.

END OF SECTION 01230

SECTION 01310 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Coordination Drawings.
 - 2. Administrative and supervisory personnel.
 - 3. Project meetings.
- B. Related Sections include the following:
 - 1. Division 1 Section "Closeout Procedures" for coordinating Contract closeout.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
1. Preparation of Contractor's Construction Schedule.
 2. Preparation of the Schedule of Values.
 3. Installation and removal of temporary facilities and controls.
 4. Delivery and processing of submittals.
 5. Progress meetings.
 6. Preinstallation conferences.
 7. Project closeout activities.
 8. Startup and adjustment of systems.
 9. Project closeout activities.

1.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - b. Indicate required installation sequences.
 - c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 2. Sheet Size: At least **8-1/2 by 11 inches** but no larger than **30 by 42 inches**.
 3. Number of Copies: Submit six opaque copies of each submittal. Architect will return three.
 4. Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

1.6 PROJECT MEETINGS

- A. General: The Architect will schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
 - 1. Attendees: Inform subcontractors and suppliers and others involved, and individuals whose presence is required, of date and time of each meeting.
 - 2. Minutes: The Architect will record significant discussions and agreements achieved.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
 - 1. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing and long-lead items.
 - d. Designation of key personnel and their duties.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for requests for interpretations (RFIs).
 - g. Procedures for testing and inspecting.
 - h. Procedures for processing Applications for Payment.
 - i. Distribution of the Contract Documents.
 - j. Submittal procedures.
 - k. Preparation of Record Documents.
 - l. Use of the premises and existing building.
 - m. Work restrictions.
 - n. Owner's occupancy requirements.
 - o. Responsibility for temporary facilities and controls.
 - p. Construction waste management and recycling.
 - q. Parking availability.
 - r. Office, work, and storage areas.
 - s. Equipment deliveries and priorities.
 - t. First aid.
 - u. Security.
 - v. Progress cleaning.
 - w. Working hours.
 - 3. Minutes: Architect will record and distribute meeting minutes.

- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. The Contract Documents.
 - b. Options.
 - c. Related requests for interpretations (RFIs).
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility problems.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written recommendations.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Progress Meetings: Architect will conduct progress meetings at weekly intervals. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in

- planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Status of correction of deficient items.
 - 14) Field observations.
 - 15) Requests for interpretations (RFIs).
 - 16) Status of proposal requests.
 - 17) Pending changes.
 - 18) Status of Change Orders.
 - 19) Pending claims and disputes.
 - 20) Documentation of information for payment requests.
 3. Minutes: Architect will record and distribute to Contractor the meeting minutes.
 4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01310

SECTION 01322 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Preconstruction videotapes.
- B. Related Sections include the following:
 - 1. Division 1 Section "Submittal Procedures" for submitting photographic documentation.
 - 2. Division 1 Section "Selective Demolition" for photographic documentation before selective demolition operations commence.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in uncompressed TIFF format, produced by a digital camera with minimum sensor size of 4.0 megapixels, and at an image resolution of not less than 1024 by 768 pixels.
- B. Videotape Format: Provide high-quality, 1/2-inch, VHS color videotape in full-size cassettes, T-90 minutes long.
 - 1. Tape quality shall be adequate to create photographic prints to be made from individual frames.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
 1. Date and Time: Include date and time in filename for each image.
 2. Field Office Images: Maintain one set of images on CD-ROM in the field office at Project site, available at all times for reference.
- C. Preconstruction Photographs: Before commencement of demolition and starting construction, take digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points.
 1. Flag construction limits before taking construction photographs.
 2. Take fifteen photographs to show existing conditions adjacent to property before starting the Work.
 3. Take fifteen photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

3.2 CONSTRUCTION VIDEOTAPES

- A. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each videotape, record weather conditions from local newspaper or television and the actual temperature reading at Project site.
- B. Narration: Describe scenes on videotape by audio narration by microphone while videotape is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
 1. Confirm date and time at beginning and end of recording.
- C. Preconstruction Videotape: Before starting demolition, record videotape of Project site and surrounding properties from different vantage points.
 1. Flag construction limits before recording construction videotapes.
 2. Show existing conditions adjacent to Project site before starting the Work.
 3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of demolition and construction.
 4. Show protection efforts by Contractor.

END OF SECTION 01322

SECTION 01330 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Sections include the following:
 - 1. Division 1 Section "Project Management and Coordination" for submitting and distributing meeting and conference minutes and for submitting Coordination Drawings.
 - 2. Division 1 Section "Closeout Procedures" for submitting warranties.
 - 3. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Divisions 2 through 16 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's responsive action. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

- A. General: Electronic copies of CAD Drawings of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals- subject to a "Hold Harmless" agreement.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

- a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
- D. Identification: Place a permanent label or title block on each submittal for identification.
 1. Indicate name of firm or entity that prepared each submittal on label or title block.
 2. Provide a space approximately **6 by 8 inches** on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
 3. Include the following information on label for processing and recording action taken:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Submittal number or other unique identifier, including revision identifier.
 - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).
 - i. Number and title of appropriate Specification Section.
 - j. Drawing number and detail references, as appropriate.
 - k. Location(s) where product is to be installed, as appropriate.
 - l. Other necessary identification.
- E. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals.

- F. Additional Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Architect.
 2. Additional copies submitted for maintenance manuals will not be marked with action taken and will be returned.
- G. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review, received from sources other than Contractor.
1. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Specification Section number and title.
 - i. Drawing number and detail references, as appropriate.
 - j. Transmittal number, numbered consecutively.
 - k. Submittal and transmittal distribution record.
 - l. Remarks.
 - m. Signature of transmitter.
 2. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same label information as related submittal.
- H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked "Reviewed, no exceptions taken", or "Furnish as corrected".
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Use only final submittals with mark indicating "Reviewed, no exceptions taken", or "Furnish as corrected" taken by Architect.

1.5 CONTRACTOR'S USE OF ARCHITECT'S CAD FILES

- A. General: At Contractor's written request, copies of Architect's CAD files will be provided to Contractor for Contractor's use in connection with Project, subject to the following conditions:
 - 1. Architect will require a "Hold Harmless" agreement.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operation and maintenance manuals.
 - k. Compliance with specified referenced standards.
 - l. Testing by recognized testing agency.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.
 - 4. Submit Product Data before or concurrent with Samples.
 - 5. Number of Copies: Submit five copies of Product Data, unless otherwise indicated. Architect will return two copies. Mark up and retain one returned copy as a Project Record Document.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

- a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 - m. Relationship to adjoining construction clearly indicated.
 - n. Seal and signature of professional engineer if specified.
 - o. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least **8-1/2 by 11 inches** but no larger than **30 by 40 inches**.
 3. Number of Copies: Submit two opaque (bond) copies of each submittal. Architect will return one copy.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. Number and title of appropriate Specification Section.
 3. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Number of Samples: Submit five sets of Samples. Architect will retain three Sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule or List: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product.
 2. Number and name of room or space.
 3. Location within room or space.
 4. Number of Copies: Submit five copies of product schedule or list, unless otherwise indicated. Architect will return two copies.
 - a. Mark up and retain one returned copy as a Project Record Document.
- F. Contractor's Construction Schedule: Comply with requirements specified in Division 1 Section "Construction Progress Documentation" for Construction Manager's action.
- G. Submittals Schedule: Comply with requirements specified in Division 1 Section "Construction Progress Documentation."
- H. Application for Payment: Comply with requirements specified in Division 1 Section "Payment Procedures."
- I. Schedule of Values: Comply with requirements specified in Division 1 Section "Payment Procedures."
- J. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.
4. Number of Copies: Submit five copies of subcontractor list, unless otherwise indicated. Architect will return two copies.
 - a. Mark up and retain one returned copy as a Project Record Document.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 1. Number of Copies: Submit three copies of each submittal, unless otherwise indicated. Architect will not return copies.
 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 3. Test and Inspection Reports: Comply with requirements specified in Division 1 Section "Quality Requirements."
- B. Coordination Drawings: Comply with requirements specified in Division 1 Section "Project Management and Coordination."
- C. Contractor's Construction Schedule: Comply with requirements specified in Division 1 Section "Construction Progress Documentation."
- D. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- H. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- I. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

- J. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- M. Schedule of Tests and Inspections: Comply with requirements specified in Division 1 Section "Quality Requirements."
- N. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- O. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- P. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- Q. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 1 Section "Operation and Maintenance Data."
- R. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

- S. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
 - 1. Preparation of substrates.
 - 2. Required substrate tolerances.
 - 3. Sequence of installation or erection.
 - 4. Required installation tolerances.
 - 5. Required adjustments.
 - 6. Recommendations for cleaning and protection.
- T. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
 - 1. Name, address, and telephone number of factory-authorized service representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Statement that products at Project site comply with requirements.
 - 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 6. Statement whether conditions, products, and installation will affect warranty.
 - 7. Other required items indicated in individual Specification Sections.
- U. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- V. Material Safety Data Sheets (MSDSs): Submit information directly to Owner; do not submit to Architect.
 - 1. Architect will not review submittals that include MSDSs and will return the entire submittal for resubmittal.

2.3 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit five copies of a statement, signed and sealed by the responsible design

professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S / ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 01330

SECTION 01731 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. Related Sections include the following:
 - 1. Division 1 Section "Selective Demolition" for demolition of selected portions of the building.
 - 2. Divisions 2 through 16 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.

1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
 - 1. Fire-suppression systems.
 - 2. Mechanical systems piping and ducts.
 - 3. Electrical wiring systems.
- C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
 - 1. Water, moisture, or vapor barriers.
 - 2. Exterior curtain-wall construction.
 - 3. Piping, ductwork, vessels, and equipment.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.

- B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 3. Concrete: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 01731

SECTION 01732 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of a building or structure.
 - 2. Repair procedures for selective demolition operations.
- B. Related Sections include the following:
 - 1. Division 1 Section "Summary" for restrictions on use of the premises due to Owner or tenant occupancy.
 - 2. Division 1 Section "Photographic Documentation" for documenting the everything within the project limit line, the state of the project site and the existing condition of adjacent structures and buildings prior to commencing demolition and construction of the project.
 - 3. Division 1 Section "Cutting and Patching" for cutting and patching procedures for selective demolition operations.
 - 4. Division 15 Sections for demolishing, cutting, patching, or relocating mechanical items.
 - 5. Division 16 Sections for demolishing, cutting, patching, or relocating electrical items.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Locations of temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- D. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- E. Predemolition Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Submit before Work begins.
- F. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Professional Engineer Qualifications: Comply with Division 1 Section "Quality Requirements."
- C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. Standards: Comply with ANSI A10.6 and NFPA 241.

- E. Predemolition Conference: Conduct conference at Project site to review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.7 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.
- B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
 - 1. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- C. Owner assumes no responsibility for condition of areas to be selectively demolished.
 - 1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site will not be permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1. If possible, retain original Installer or fabricator to patch the exposed Work listed below that is damaged during selective demolition. If it is impossible to engage original Installer or fabricator, engage another recognized experienced and specialized firm.
 - a. Matched-veneer woodwork.
 - b. Firestopping.
 - c. Wall covering.
 - d. HVAC enclosures, cabinets, or covers.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 2. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.
 - 1. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
 - 4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
- D. Utility Requirements: Refer to Division 15 and 16 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- A. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with selective demolition operations.
- B. Pest Control: Employ a certified, licensed exterminator to treat building and to control rodents and vermin before and during selective demolition operations.
- C. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
 - 2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
 - 3. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 4. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.

- D. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
- E. Temporary Enclosures: Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
- F. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.
- G. Temporary Shoring: Provide and maintain interior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.

3.4 POLLUTION CONTROLS

- A. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations.
 - 1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
 - 2. Wet mop floors to eliminate trackable dirt and wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.
- B. Disposal: Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 1. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- C. Cleaning: Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.5 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain adequate ventilation when using cutting torches.
 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 9. Dispose of demolished items and materials promptly.
 10. Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.
- B. Existing Facilities: Comply with building manager's requirements for using and protecting elevators, stairs, walkways, loading docks, building entries, and other building facilities during selective demolition operations.
- C. Removed and Salvaged Items: Comply with the following:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items: Comply with the following:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- F. Resilient Floor Coverings, Resilient Base and Accessories: Remove floor coverings, base and adhesive according to recommendations in RFCI-WP and its Addendum.
 1. Remove residual adhesive and prepare substrate for new floor coverings by one of the methods recommended by RFCI.

3.6 PATCHING AND REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.
- B. Patching: Comply with Division 1 Section "Cutting and Patching."
- C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
 1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.
- D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.
- E. Floors and Walls: Where walls or partitions that are demolished extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
 2. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
 3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
- F. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

END OF SECTION 01732

SECTION 01770 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Warranties.
 - 3. Final cleaning.
- B. Related Sections include the following:
 - 1. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 2. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

8. Complete startup testing of systems.
9. Submit test/adjust/balance records.
10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
11. Advise Owner of changeover in heat and other utilities.
12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
13. Complete final cleaning requirements, including touchup painting.
14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training videotapes.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 WARRANTIES

A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive **8-1/2-by-11-inch** paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

- d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - g. Sweep concrete floors broom clean in unoccupied spaces.
 - h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - j. Remove labels that are not permanent.
 - k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - m. Replace parts subject to unusual operating conditions.
 - n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - p. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - r. Leave Project clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- D. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 01770

SECTION 01781 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Sections include the following:
 - 1. Division 1 Section "Closeout Procedures" for general closeout procedures.
 - 2. Divisions 2 through 16 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up Record Prints.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION 01781

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Slabs-on-grade.
- B. Related Sections include the following:
 - 1. Division 3 Section "Concrete Curing and Sealing" for exposed interior concrete floors.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Samples: For vapor retarder.
- E. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- C. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1.

- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 , deformed bars, assembled with clips.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years'

satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.7 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products:
 - a. Fortifiber Corporation; Moistop Ultra.
 - b. Raven Industries Inc.; Vapor Block 10.
 - c. Stego Industries, LLC; Stego Wrap, 15 mils.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edoco; BurkeFilm.

- c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, Div. of ChemRex; Confilm.
 - k. Meadows, W. R., Inc.; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
 - p. Unitex; Pro-Film.
 - q. US Mix Products Company; US Spec Monofilm ER.
 - r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. Products:
- a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Burke by Edoco; Aqua Resin Cure.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - f. Euclid Chemical Company (The); Kurez DR VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; Aqua Kure-Clear.
 - i. L&M Construction Chemicals, Inc.; L&M Cure R.
 - j. Meadows, W. R., Inc.; 1100 Clear.
 - k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
 - l. Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
 - m. Tamms Industries, Inc.; Horncrete WB 30.
 - n. Unitex; Hydro Cure 309.
 - o. US Mix Products Company; US Spec Maxcure Resin Clear.
 - p. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber .
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 15 percent.

- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Minimum Cementitious Materials Content: 520 lb/cu. yd.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.
 - 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

2.13 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than **50 deg F** for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.
- C. Granular Course: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/4 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 - 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least **6 inches** into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below **40 deg F** for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

2. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or stone tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least four month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than ½ inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
 2. Steel reinforcement welding.
 3. Headed bolts and studs.
 4. Verification of use of required design mixture.

5. Concrete placement, including conveying and depositing.
 6. Curing procedures and maintenance of curing temperature.
 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 03300

SECTION 03310 - CONCRETE CURING AND SEALING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies concrete curing and sealing for exposed interior concrete floors.
- B. Related Sections: Division 3 Section "Cast-In-Place Concrete" for concrete and formwork.

1.3 SUBMITTALS

- A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for proprietary materials and items.
- C. Manufacturer's recommended installation procedures.
- D. Manufacturer's specifications, test data and other data required to indicate compliance with the specified requirements.

1.4 QUALITY ASSURANCE

- A. Use factory approved applicator with adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
- B. No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential. Comply with the following requirements at exposed, sealed concrete floors:
 - 1. Diaper hydraulic powered equipment to avoid staining of the concrete.
 - 2. Do not park vehicles on the inside slab. If necessary to complete other scope of work, place drop clothes under vehicles at all times.
 - 3. Do not use pipe cutting machines.
 - 4. Do not place steel on concrete to avoid rust staining.
 - 5. Finish concrete with a smooth, hard, glazed, steel-troweled finish.

1.5 PRODUCT HANDLING

- A. Protect the materials of this Section before and after installation. Protect the work and materials of all other trades.
- B. In the event of damage, immediately make replacements and repairs to the approval of the Architect and at no additional cost to the Owner.

1.6 WARRANTY

- A. Upon completion of the work, as a condition of its acceptance, provide the Owner a written warranty signed by an officer of Curecrete Distribution, Inc.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Curing, Hardening and Sealing Agent:
 - 1. "ASHFORD FORMULA" as manufactured by Curecrete Distribution, Inc at 1203 West Spring Creek Place, Springville, Utah 84663. Phone: 800.998.5664.
 - 2. "SEAL HARD" as manufactured by L & M Construction Chemical, Inc.
- B. Substitutions must be approved by the Architect prior to bidding.
- C. All material must be dispensed from factory numbered and sealed drums and recorded for owners' review.

PART 3 - EXECUTION

3.1 INITIAL APPLICATION

- A. Use as curing agent and apply at the rate of 200 square feet per gallon at time of concrete placement. Comply with the following:
 - 1. Application should be made immediately following the final concrete finishing operation as soon as the concrete is firm enough to work on. This will help prevent temperature crazing.
 - 2. Application shall be made with a low pressure spray. All concrete surfaces shall be kept wet with the Ashford Formula for 30-40 minutes, after which the Ashford will become slippery or gel-like underfoot.
 - 3. When the treated surface becomes slippery, lightly sprinkle with water to aid penetration. This will cause material to lose its slipperiness.

4. After the material begins to gel once again, flush the entire surface with water to remove excess material, alkali, or impurities. Squeegee off all water and residue, leaving floor dry.

3.2 FINISH APPLICATION

- A. Apply the finish coat after racking and final cleaning of the concrete. Comply with the following:
 1. Allow minimum of 14 days between initial application of Ashford and finish application. Clean floor surface thoroughly. The finish application must be applied to Ashford-treated concrete that is clean, bare, and free of contaminants.
 2. On a 200 SF test area, spray the Ashford on the floor surface *very lightly*. Using a lambswool applicator, evenly distribute the material. Application should be light enough that lambswool pushes no excess material in front of it. Start timing immediately.
 - a. The sample area should be damp to the touch at 30 minutes, and dry to the touch at 45 minutes. If drying takes longer, apply material more sparingly. If drying takes less time, then apply material more liberally.
 3. Once application rate has been determined from the sample test, apply material to remainder to floor at same rate. Note: Typical application rate is 600 to 700 SF per gallon for steel-troweled finishes.
 4. Keep standing water off concrete surface for 30 days. Do not wet scrub for 30 days.

END OF SECTION 03310

SECTION 04810 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units (CMUs).
 - 2. Face brick.
 - 3. Mortar and grout.
 - 4. Reinforcing steel.
 - 5. Masonry joint reinforcement.
 - 6. Ties and anchors.
 - 7. Embedded flashing.
 - 8. Miscellaneous masonry accessories.
 - 9. Masonry-cell insulation.
- B. Related Sections include the following:
 - 1. Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry, furnished under Division 5 Section "Metal Fabrications."

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths (f'_m) at 28 days.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection: For the following:
 - 1. Face brick, in the form of straps of five or more bricks.
 - 2. Colored mortar.
- D. Samples for Verification: For each type and color of the following:
 - 1. Exposed concrete masonry units.
 - 2. Face brick, in the form of straps of five or more bricks.
 - 3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
- E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports, per UBC Standard 21-16, for mortar mixes required to comply with property specification.
 - 2. Include test reports, per UBC Standard 21-18, for grout mixes required to comply with compressive strength requirement.
- F. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Table 21-D in the Uniform Building Code.
- G. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

- D. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by Owner. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
 - 1. Prism Test: For each type of construction required, per ASTM C 1314.
- E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 1 Section "Quality Requirements" for mockups.
 - 1. Build sample panels for typical exterior wall in sizes approximately 48 inches long by 48 inches high by full thickness.
 - 2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
 - 3. Clean one-half of exposed faces of panels with masonry cleaner indicated.
 - 4. Protect approved sample panels from the elements with weather-resistant membrane.
 - 5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 - 2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. **Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.**
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide bullnose units for outside corners, unless otherwise indicated.
- B. Concrete Masonry Units: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
 - 2. Weight Classification: Lightweight.
 - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.4 MASONRY LINTELS

- A. General: Provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 BRICK

- A. General: Provide shapes indicated and as follows:
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 - 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 - 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Face Brick: ASTM C 216, Grade SW, Type FBX-Facing.

1. Products:
 - a. IXL Brick, available from Interpace Brick- (801)282-6621
2. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
3. Colors: Match Architect's samples.

2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
- D. Masonry Cement: ASTM C 91.
 1. Available Products:
 - a. Capital Materials Corporation; Flamingo Color Masonry Cement.
 - b. Essroc, Italcementi Group;
 - c. Holcim (US) Inc.;
 - d. Lafarge North America Inc.;
 - e. Lehigh Cement Company;
 - f. National Cement Company, Inc.; Coosa Masonry Cement.
- E. Mortar Cement: ASTM C 1329.
 1. Available Products:
 - a. Lafarge North America Inc.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. Products:
 - a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
 - b. Davis Colors; True Tone Mortar Colors.
 - c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
- G. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Available Products:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company (The); Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.
- I. Water: Potable.

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951.
1. Exterior Walls: Hot-dip galvanized, carbon steel.
 2. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
 3. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
 4. Wire Size for Veneer Ties: W2.8 or 0.188-inch diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Multiwythe Masonry:
1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.
- E. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- diameter, hot-dip galvanized, carbon-steel continuous wire.

2.8 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
 - 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
 - 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
 - 1. Wire: Fabricate from 3/16-inch diameter, hot-dip galvanized steel wire.

2.9 EMBEDDED FLASHING MATERIALS

- A. Flexible Flashing: For flashing not exposed to the exterior, use the following, unless otherwise indicated:
 - 1. Copper-Laminated Flashing: Asphalt-Coated Copper Flashing: 5-oz./sq. ft. copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
 - a. Products:
 - 1) Advanced Building Products Inc.; Cop-R-Cote.
 - 2) AFCO Products Inc.; Cop-A-Cote.
 - 3) Hohmann & Barnard, Inc.; H & B C-Coat Flashing.
 - 4) Phoenix Building Products; Type ACC-Asphalt Bituminous Coated.
 - 5) Polytite Manufacturing Corp.; Coated Copper Flashing.
 - 6) Sandell Manufacturing Co., Inc.; Coated Copper Flashing.
 - 7) York Manufacturing, Inc.; Copperseal.
- B. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 MASONRY-CELL INSULATION

- A. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

1. Available Products:
 - a. Concrete Block Insulating Systems; Korfil.
 - b. Shelter Enterprises Inc.; Omni Core.

2.11 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Available Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Limit cementitious materials in mortar to portland cement[, **mortar cement**,] and lime.
 3. Limit cementitious materials in mortar for exterior[**and reinforced**] masonry to portland cement[, **mortar cement**,] and lime.
 4. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is.
 1. For masonry below grade or in contact with earth, use Type S.
 2. For reinforced masonry, use Type S.
 3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
 4. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Pigmented Mortar: Use colored cement.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of mortar cement by weight.
3. Mix to match Architect's sample.

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

2.13 SOURCE QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below:
1. Payment for these services will be made by Owner.
 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- B. Clay Masonry Unit Test: For each type of unit furnished, per ASTM C 67.
- C. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- H. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet maximum.
 - 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet maximum.
 - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet maximum.
 - 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 3/8 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 - 5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 - 6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
 - 7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow concrete masonry units with grout under bearing plates, beams, lintels, posts, and similar items, as shown on the drawings.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.5 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
 - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one **metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.**

- a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
 3. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not over 12 inches clear horizontally and 16 inches clear vertically.
 4. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.6 MASONRY-CELL INSULATION

- A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story in height, but not more than 20 feet.
- B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 1. Space reinforcement not more than 16 inches o.c.
 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
 - a. Reinforcement above is in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at corners by using prefabricated L-shaped units.
- D. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within ½ inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
 - 3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and 1-1/2 inches into the inner wythe.
 - 4. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
 - 5. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 - 6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing ½ inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
 - 7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing ½ inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
 - 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use open head joints to form weep holes.
 2. Space weep holes 24 inches o.c., unless otherwise indicated.
- E. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches, to maintain drainage.
1. Fill cavities full height by placing pea gravel in cavities as masonry is laid so that at any point masonry does not extend more than 24 inches above top of pea gravel.

3.10 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches.

3.11 FIELD QUALITY CONTROL

- A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
- B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
1. Payment for these services will be made by Owner.
 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

- D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.
- E. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
- F. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.
- G. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019
- H. Prism Test: For each type of construction provided, per ASTM C 131 at 7 days and at 28 days.

3.12 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 04810

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel.
- B. Related Sections include the following:
 - 1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
 - 2. Division 5 Section "Steel Deck" for field installation of shear connectors.
 - 3. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other metal items not defined as structural steel.
 - 4. Division 9 painting Sections for surface preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.
- B. Construction: Type PR, partially restrained.
- C. Construction: Type 2, simple framing.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
- C. Welding certificates.
- D. Qualification Data: For Installer fabricator testing agency.
- E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Tension-control, high-strength bolt-nut-washer assemblies.
 - 4. Shear stud connectors.
 - 5. Shop primers.
- F. Source quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: **[ASTM A 992/A 992M]**.
- B. Channels, Angles-Shapes: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: **ASTM A 325**, Type 1, heavy hex steel structural bolts.
 1. Finish: Plain.
- B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- C. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.
 1. Finish: Plain.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

2.4 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

1. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- E. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 1. Cut, drill, or punch holes perpendicular to steel surfaces.
 2. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.5 SHOP CONNECTIONS

- A. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

2.6 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 1. Surfaces to be field welded.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 1. SSPC-SP 2, "Hand Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than **1.5 mils**. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds.
- B. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

3.6 REPAIRS AND PROTECTION

- A. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION 05120

SECTION 05310 - STEEL DECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof deck.
- B. Related Sections include the following:
 - 1. Division 5 Section "Structural Steel" for shop- and field-welded shear connectors.
 - 2. Division 5 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
- C. Welding certificates.
- D. Field quality-control test and inspection reports.
- E. Research/Evaluation Reports: For steel deck.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
- B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

- C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Deck:
 - a. ASC Profiles, Inc.
 - b. Nucor Corp.; Vulcraft Division.
 - c. Vercor Manufacturing Co.

2.2 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade , **G60** zinc coating.
 - 2. Deck Profile: As indicated.
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: As indicated.
 - 5. Span Condition: Triple span or more.
 - 6. Side Laps: Interlocking seam.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

- B. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- C. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than **1-1/2 inches** long, and as follows:
 - 1. Weld Diameter: **3/4 inch**, nominal.
 - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds **6 inches** apart, maximum.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or [**18 inches**] [**36 inches**], and as follows:
 - 1. Fasten with a minimum of **1-1/2-inch-** long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of **1-1/2 inches**, with end joints as follows:

1. End Joints: Lapped **2 inches** minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than **6 inches** apart with at least one weld at each corner.
 1. Install reinforcing channels or zees in ribs to span between supports and weld.

3.4 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

END OF SECTION 05310

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 2. Shelf angles.
 - 3. Metal ladders.
 - 4. Metal bollards.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
- C. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
 - 2. Division 4 Section "Unit Masonry Assemblies" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
 - 3. Division 5 Section "Structural Steel."
 - 4. Division 6 Section "Miscellaneous Carpentry" for metal framing anchors.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 - 2. Provide allowance for trimming and fitting at site.

1.6 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

- B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type [304] [316] stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36.
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- D. Plain Washers: Round, ASME B18.22.1.
- E. Lock Washers: Helical, spring type, ASME B18.21.1.
- F. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 9 painting Sections.
- C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
 - 1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Products:
 - a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.
 - b. Carboline Company; Carbozinc 621.
 - c. ICI Devoe Coatings; Catha-Coat 313.

- d. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.
- e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
- f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
- g. Tnemec Company, Inc.; Tneme-Zinc 90-97.

- D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- H. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of **3000 psi**, unless otherwise indicated.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch**, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
 - 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, **1/8 by 1-1/2 inches**, with a minimum **6-inch** embedment and **2-inch** hook, not less than **8 inches** from ends and corners of units and **24 inches** o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts if units are installed after concrete is placed.
- C. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than **8 inches**, unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.

2.8 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, unless otherwise indicated.
2. Space siderails **18 inches** apart, unless otherwise indicated.
3. Support each ladder at top and bottom and not more than **60 inches** o.c. with welded or bolted brackets, made from same metal as ladder.

B. Steel Ladders:

1. Siderails: Continuous 1 ½" (1.9" OD) pipe.
2. Rungs: 1 ½" pipe (1.9" OD).
3. Prime, including brackets and fasteners, with zinc-rich primer.

2.9 METAL BOLLARDS

A. Fabricate metal bollards from **1/4-inch** wall-thickness rectangular steel tubing.

1. Cap bollards with **1/4-inch-** thick steel plate.
2. Where bollards are indicated to receive push-button controls for door operators, provide necessary cutouts for push-button controls and hole for wire.

2.10 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.11 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLING METAL BOLLARDS

- A. Anchor bollards in concrete in formed or core-drilled holes not less than **8 inches** deep and **3/4 inch** larger than OD of bollard. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch** toward bollard.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum **2.0-mil** dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05500

SECTION 06100 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Rooftop equipment bases and support curbs.
 - 2. Wood blocking and nailers.

1.3 DEFINITIONS

- A. Dimension Lumber: Lumber of **2 inches nominal** or greater but less than **5 inches nominal** in least dimension.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Engineered Wood Products: Obtain each type of engineered wood product through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

2.2 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Nailers.
 2. Rooftop equipment bases and support curbs.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content and the following species:
 1. Hem-fir; WCLIB, or WWPA.
 2. Western woods; WCLIB or WWPA.
- C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: **ASME B18.2.1.**
- F. Bolts: Steel bolts complying with **ASTM A 307, Grade A**; with **ASTM A 563** hex nuts and, where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

- B. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06100

SECTION 07540 - THERMOPLASTIC MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Mechanically fastened membrane roofing system.
 - 2. Roof insulation.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Division 7 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
 - 3. Division 7 Section "Joint Sealants."

1.3 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.
- C. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.

1. Fire/Windstorm Classification: Class 1A- 90.
2. Hail Resistance: MH.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.
 1. Base flashings and membrane terminations.
 2. Tapered insulation, including slopes.
 3. Insulation fastening patterns.
- C. Samples for Verification: For the following products:
 1. **12-by-12-inch** square of sheet roofing, of color specified, including T-shaped side and end lap seam.
 2. **12-by-12-inch** square of roof insulation.
 3. **12-by-12-inch** square of walkway pads or rolls.
 4. Six insulation fasteners of each type, length, and finish.
 5. Six roof cover fasteners of each type, length, and finish.
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
- E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 1. Submit evidence of meeting performance requirements.
- F. Qualification Data: For Installer and manufacturer.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.
- H. Research/Evaluation Reports: For components of membrane roofing system.
- I. Maintenance Data: For roofing system to include in maintenance manuals.
- J. Warranties: Special warranties specified in this Section.
- K. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
- B. Manufacturer Qualifications: A qualified manufacturer that has FMG approval for membrane roofing system identical to that used for this Project.
- C. Source Limitations: Obtain components for membrane roofing system from roofing membrane manufacturer.
- D. Fire-Test-Response Characteristics: Provide membrane roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.
 - 2. Fire-Resistance Ratings: ASTM E 119, for fire-resistance-rated roof assemblies of which roofing system is a part.
- E. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.
 - 8. Review temporary protection requirements for roofing system during and after installation.
 - 9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
 1. Special warranty includes roofing membrane, base flashings, roofing membrane accessories roof insulation fasteners walkway products and other components of membrane roofing system.
 2. Warranty Period: 20 years from date of Substantial Completion.
 3. Attached additional warranty form to be completed and signed by roofing manufacturer.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
 1. Warranty Period: Five years from date of Substantial Completion.
 2. Attached additional warranty form to be completed and signed by roofing contractor.

PART 2 - PRODUCTS

2.1 PVC ROOFING MEMBRANE

- A. PVC Sheet: ASTM D 4434, Type III, fabric reinforced.
 1. Manufacturers:
 - a. Firestone Building Products Company.
 - b. GAF Materials Corporation.

- c. Johns Manville International, Inc.
 - d. Sarnafil Inc.
- 2. Thickness: 80-mil.
 - 3. Exposed Face Color: White.

2.2 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet membrane.
- C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
- D. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately **1 by 1/8 inch** thick; with anchors.
- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- F. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories.

2.3 ROOF INSULATION

- A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, **1.6-lb/cu. ft.** minimum density, square edged.
 - 1. Available Manufacturers:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company.
 - c. Owens Corning.
 - d. Tenneco Building Products.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of **1/4 inch per 12 inches**, unless otherwise indicated.

2.4 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

2.5 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately **3/16 inch** thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is **2 inches** or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of **6 inches** in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding **1/4 inch** with insulation.
 - 1. Cut and fit insulation within **1/4 inch** of nailers, projections, and penetrations.
- G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.

3.4 MECHANICALLY FASTENED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
 - 1. Install sheet according to ASTM D 5082.
- B. Accurately align roofing membranes and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- D. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- E. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
 - 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.
- F. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.
- G. In-Splice Attachment: Secure one edge of roofing membrane using fastening plates or metal battens centered within membrane splice and mechanically fasten roofing membrane to roof deck. Field-splice seam.

3.5 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with sheet flashing.
- D. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.

3.6 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.
- B. Rubber Roof-Paver Walkways: Install rubber roof-paver walkways according to manufacturer's written instructions, loosely laid, in locations indicated.
- C. Roof-Paver Walkways: Install heavyweight walkway roof pavers according to manufacturer's written instructions in locations indicated, to form walkways. Leave **3 inches** of space between adjacent roof pavers.

3.7 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 1. Notify Architect or Owner 48 hours in advance of date and time of inspection.
- B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3.9 ROOFING INSTALLER'S WARRANTY

- A. See the following attached two documents.

END OF SECTION 07540



State of Utah

Division of Facilities Construction and Management
4110 State Office Building Salt Lake City, Utah 84114
Phone: 801-538-3018 Fax: 801-538-3267

CONTRACTOR ROOFING WARRANTY

WHEREAS _____

Of (Address) _____

Herein called the "Roofing Contractor", has performed roofing and associated ("work") on following project:

Owner: _____ DFCM Project No. _____

Address: _____

Name and Type of Building: _____ State Building Number _____

Address: _____

Area of Work: _____ Date of Acceptance: _____

Warranty Period: _____ (5) years _____ Date of Expiration: _____

AND WHEREAS Roofing Contractor has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period.

NOW THEREFORE Roofing Contractor hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work, and as are necessary to maintain said work in watertight condition. In addition to making the work watertight, the Roofing Contractor shall remove and/or repair blisters, ridges, flashings, splits and other irregularities which in the opinion of the Roofing Manufacturer's technical representative do not conform to acceptable roofing practices and conditions. These repairs shall be made prior to expiration of the five (5) year Warranty Period and to the satisfaction of the Roofing Manufacturer's technical representative.

This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by: a) lightning, windstorm; b) fire; c) failure of roofing system substrate including cracking settlement, excessive deflection, deterioration, and decomposition; d) faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work; and e) activity on roofing by others including construction contractors, maintenance personnel, other persons, and animals whether authorized or unauthorized by Owner,

When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Contractor, and until cost and expense thereof has been paid by Owner or by another responsible party so designated.

2. The Roofing Contractor is responsible for damage to work covered by this Warranty, but is not liable for consequential damages to building or building contents, resulting from leaks or faults or defects of work.
3. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Contractor, including cutting, patching and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void upon date of said alterations, but only to extent said alterations affect work covered by this Warranty. If Owner engages Roofing Contractor to perform said alterations, Warranty shall not become null and void, unless Roofing Contractor, prior to proceeding with said work, shall claim that said alterations would like damage or deteriorate work, thereby reasonably justifying a limitation or termination of this warranty.
4. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void upon date of said change, but only to extent said change affects work covered by this Warranty.
5. The Owner shall promptly notify Roofing Contractor of observed, known or suspected leaks, defect or deterioration, and shall afford reasonable opportunity for Roofing Contractor to inspect work, and to examine evidence of such leaks, defects or deterioration.
6. This Warranty is recognized to be the only Warranty of Roofing Contractor on said work, and is in addition to the Roofing Guarantee furnished by the Roofing Manufacturer, and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to him in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Contractor of responsibility for performance of original work in accordance with requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owners General Contractor.

IN WITNESS THEREOF, this instrument has been dully executed this _____ day of _____, 20_____.

Cosigned by General Contractor by:

(General Contractor)

(Roofing Contractor)

(Business Address)

(Business Address)

(Signature)

(Signature)

(Title)

(Title)



State of Utah

Division of Facilities Construction and Management
4110 State Office Building Salt Lake City, Utah 84114
Phone: 801-538-3018 Fax: 801-538-3267

GUARANTEE FOR SINGLE-PLY ROOFING

WHEREAS, _____, a corporation whose address is _____, hereinafter called the Manufacturer, has manufactured and sold and caused to have applied, pursuant to the specifications and inspection, the necessary roofing materials to construct a _____ roof of approximately _____ square feet and associated roof flashing of approximately _____ linear feet on the building described below:

OWNER: _____

DFCM PROJECT NO: _____ STATE BUILDING NO: _____

BUILDING: _____

LOCATION: _____

DATE OF COMPLETION OF ROOFING: _____, 20____

BY: _____ (ROOFER)

_____ (ADDRESS)

ROOFING SPECIFICATION: _____

MANUFACTURER'S GUARANTEE NO: _____

AND WHEREAS, by careful examination of said roof by the Manufacturer's representative, it has been determined that required quantities of roofing materials have been used and that roofing materials have been applied in conformance with Manufacturer's specifications.

AND WHEREAS, Manufacturer represents and wishes to guarantee, subject to the limits stated herein, that its roofing when so applied is effectively watertight for a period of twenty (20) years despite normal wear and tear by the elements, as well as guaranteeing it against defects in workmanship or materials; which result in leaks.

NOW THEREFORE, said Manufacturer guarantees to the said Owner that, as set forth below, during a period of twenty (20) years from the date of substantial completion of said single-ply roofing described above, Manufacturer will at its own expense, make or cause to be made, any repairs that may be necessary, as a result of defects in workmanship or materials supplied by the Manufacturer which results in leaks or of normal wear and tear by the elements which results in leaks, and will maintain said roof in water tight condition free from all leaks arising from such causes. For purposes of this Guaranty, damage to the roof caused by hurricanes, lightning, tornadoes, gales, hailstorms or other unusual natural phenomena shall not be deemed to be "normal wear and tear by the elements".

INCLUSIONS: This Guaranty does cover, and Manufacturer shall be liable for the following:

1. Roofing membrane, membrane flashings, metal flashings, mechanical fastening system, anchors, adhesives, seaming materials, slip sheets, fabrics, insulations, underlayments, and accessories furnished by the Manufacturer as incorporated into the roof membrane system.
2. Replacement of roof insulation and/or vapor barrier damages by any leakage and/or failure of the roof membrane assembly.
3. Repair of splits, breaks, cracks, and seam failures in membrane system.

EXCLUSIONS: This Guaranty does not cover, and Manufacturer shall not be liable for the following:

1. Metal work, including metal counter flashings, not a part of the roof membrane system and such damage as may result from application of these materials;
2. Any damage to the roof caused by structural defect in, or failure of, the building or defects in, or failure of, any structural roof deck, or other sheathing materials, used as the base over which the roof and roof insulation is applied;
3. Roof damage from special chemical conditions not disclosed to Manufacturer;
4. Any damage to the building or contents thereof, except replacement of damaged roof insulation and vapor barrier as noted under "INCLUSION" above;
5. Roof damage through use of materials after original installation not furnished or authorized by Manufacturer;
6. Damage to the roof due to mechanical abrasion or abuse not caused by the Manufacturer.
7. Reasonable care and maintenance will be the responsibility of the Owner.

INSPECTION AND REPAIR: During the term of this Guarantee, Manufacturer, its agents or employees, shall have free access to the roof during regular business hours. Upon written notice by Owner to Manufacturer within four days of the discovery of any leaks in the roofing system, or

need of repair of roof, the Manufacturer shall have ten (10) days to inspect the roof. Following such inspection:

1. Manufacturer, at its own expense shall make such repairs to there of as are required by the Guaranty.
2. In case owner or his agent has notified Manufacturer in writing that repairs are required and such repairs are not covered by the Guaranty (including repairs required by owner's alteration, extension or addition to the roof) Owner, after having obtained Manufacturer's consent thereto, in writing, shall make or cause to be made, such repairs at Owner's expense in accordance with specifications and procedures as established by Manufacturer and this Guaranty shall thereupon remain in effect for the un-expired portion of its original term. If Owner fails to obtain authorization from Manufacturer or if repairs are made by one other than the Manufacturer's authorized designee, this Guaranty with respect to such area shall be automatically terminated.
3. In the event the (1) Owner notifies Manufacturer and has confirmed in writing the need of repair of roof and (2) Manufacturer is unable to promptly inspect and repair same, and (3) an emergency condition exists which requires prompt repair in order to avoid substantial damage to owner, then owner may make such temporary repairs as may be essential and any such action shall not be a breach of the provision of this Guaranty. Owner will bear emergency repair expenses.

INSPECTION SERVICE: Manufacturer agrees to re-inspect the completed roof not earlier than 18 nor later than 24 months after completion of the roofing, and if it is determined that there are defects in the roofing, then Manufacturer shall make, or cause to be made at its own expense, such repairs as are necessary to remedy said defects within the scope of its responsibility under the terms of this Guaranty.

IN WITNESS WHEREOF, Manufacturer has caused this instrument to be signed and sealed by its duly authorized officer this _____ day of _____, 20____.

BY: _____

TITLE: _____

CORPORATION: _____

SEAL:

Project Manager Approval
Division of Facilities Construction and Management

SECTION 07620 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
 - 1. Formed wall flashing and trim.
 - 2. Formed equipment support flashing.
- B. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Division 7 Section "Thermoplastic Membrane Roofing" for installing sheet metal flashing and trim integral with roofing membrane.
 - 3. Division 7 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
- C. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

- A. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
- B. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Sheet Metal Flashing: **12 inches** long. Include fasteners, closures, and other attachments.
 - 2. Trim: **12 inches** long. Include fasteners and other exposed accessories.
 - 3. Accessories: Full-size Sample.

1.5 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, **G90** coating designation; structural quality.

2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
- B. Lead Sheet: ASTM B 749, Type L51121, copper-bearing lead sheet.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 1. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
 2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
- C. Solder for Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
- D. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.
- E. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
- F. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

- C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 - 1. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, filled with elastomeric sealant concealed within joints.
- F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 - 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" and FMG Loss Prevention Data Sheet 1-49 for application but not less than thickness of metal being secured.

2.4 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Copings: Fabricate in minimum **96-inch-** long, but not exceeding **10-foot-** long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.
 - 1. Joint Style: Standing seam.
 - 2. Fabricate copings from the following material:
 - a. Prepainted, Metallic-Coated Steel: 24 Gauge thick.
- B. Counterflashing: Fabricate from the following material:
 - 1. Galvanized Steel: 20 Gauge thick.
 - 2. Prepainted, Metallic-Coated Steel: 20 Gauge thick.

2.5 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following material:
 - 1. Galvanized Steel: 20 Gauge thick.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- C. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- D. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 1. Space cleats not more than **12 inches** apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
- E. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of **10 feet** with no joints allowed within **24 inches** of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be

sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than **1 inch** deep, filled with elastomeric sealant concealed within joints.

- F. Fasteners: Use fasteners of sizes that will penetrate substrate not less than **1-1/4 inches** for nails and not less than **3/4 inch** for wood screws.
 - 1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Aluminum: Use aluminum or stainless-steel fasteners.
 - 3. Copper: Use copper, hardware bronze, or stainless-steel fasteners.
 - 4. Stainless Steel: Use stainless-steel fasteners.
- G. Seal joints with elastomeric sealant as required for watertight construction.
 - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than **1 inch** into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between **40 and 70 deg F**, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below **40 deg F**.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."
- H. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of **1-1/2 inches** except where pretinned surface would show in finished Work.
 - 1. Do not solder prepainted, metallic-coated steel sheet.
 - 2. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF FLASHING INSTALLATION

- A. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
 - 1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at 8" centers.
- B. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
 - 1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at 8" centers.
 - 2. Anchor interior leg of coping with screw fasteners and washers at **24-inch** centers.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of **4 inches** over base flashing. Install stainless-steel draw band and tighten.

- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing **4 inches** over base flashing. Lap counterflashing joints a minimum of **4 inches** and bed with elastomeric sealant.
 - 1. Secure in a waterproof manner by means of interlocking folded seam or blind rivets and sealant.
- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:
 - 1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
 - 2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.4 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07620

SECTION 07720 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof hatches.
- B. Related Sections include the following:
 - 1. Division 5 Section "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
 - 2. Division 6 Section "Rough Carpentry" for roof sheathing, wood cants, and wood nailers.
 - 3. Division 7 Section "Sheet Metal Flashing and Trim" for shop- and field-fabricated metal flashing and counterflashing, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

1.3 SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.
- C. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
- D. Samples: For each type of exposed factory-applied finish required and for each type of roof accessory indicated, prepared on Samples of size to adequately show color.

- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
 - 1. With Architect's approval, adjust location of roof accessories that would interrupt roof drainage routes.

1.8 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers listed in other Part 2 articles.

2.2 METAL MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, **G90** coated and mill phosphatized for field painting.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, **AZ50** coated.
- C. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by hot-dip process and prepainted by coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Galvanized Steel Sheet: ASTM A 653/A 653M, **G90** coated.
 - 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, **Class AZ50** coated.
 - 3. Exposed Finishes: High-Performance Organic Finish (2-Coat Fluoropolymer): Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
 - a. Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements in AAMA 2604 AAMA 2605, except as modified below:

2.3 MISCELLANEOUS MATERIALS

- A. Glass-Fiber Board Insulation: ASTM C 726, **1 inch** thick.
- B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than **1-1/2 inches** thick.
- C. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for **15-mil** dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- D. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.
- E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

- F. Elastomeric Sealant: ASTM C 920, silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- G. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, and heavy bodied for hooked-type expansion joints with limited movement.
- H. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.4 ROOF HATCHES

- A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated double-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
 - 1. Manufacturers:
 - a. Babcock-Davis; a Cierra Products Inc. Company.
 - b. Bilco Company (The).
 - c. J. L. Industries, Inc.
 - d. Milcor Inc.; a Gibraltar Company.
 - e. Nystrom, Inc.
 - f. Wasco Products, Inc.
 - 2. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.
 - 3. Type and Size: Single-leaf lid, 30 by 36 inches.
 - 4. Curb and Lid Material: Galvanized steel sheet, 0.079 inch thick.
 - a. Finish: Prime painted.
 - 5. Insulation: Glass-fiber board.
 - 6. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
 - 7. Exterior Curb Liner: Manufacturer's standard metal liner of same material and finish as metal curb.
 - 8. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
 - 9. Hardware: Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
 - a. Provide 2-point latch on covers larger than 84 inches.
 - b. Provide remote-control operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
 - 2. Verify dimensions of roof openings for roof accessories.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Install roof accessories to fit substrates and to result in watertight performance.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.
- D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
- E. Roof Hatch Installation:
 - 1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.
 - 2. Attach safety railing system to roof hatch curb.
 - 3. Attach ladder safety post according to manufacturer's written instructions.
- F. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

3.3 TOUCH UP

- A. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Division 9 painting Sections.

- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.4 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 07720

SECTION 07920 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes joint sealants for the following locations:

1. Exterior joints in vertical surfaces and nontraffic horizontal surfaces as indicated below:
 - a. Joints as indicated.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data from manufacturers for each joint sealant product required.
- C. Samples for initial selection purposes in form of manufacturer's standard bead samples, consisting of strips of actual products showing full range of colors available, for each product exposed to view.
- D. Certificates from manufacturers of joint sealants attesting that their products comply with specification requirements and are suitable for the use indicated.
- E. Compatibility and adhesion test reports from elastomeric sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.
- F. Product test reports for each type of joint sealants indicated, evidencing compliance with requirements specified.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility for Joint Sealant Materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
 - 2. When joint substrates are wet.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.7 SEQUENCING AND SCHEDULING

- A. Sequence installation of joint sealants to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- B. Colors: Provide color of exposed joint sealants to comply with the following:
 - 1. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.

2.2 ELASTOMERIC JOINT SEALANTS

- A. **Elastomeric Sealant Standard:** Provide manufacturer's standard chemically curing elastomeric sealants that comply with ASTM C 920 and other requirements indicated on each Elastomeric Joint Sealant Data Sheet at end of this Section, including those requirements referencing ASTM C 920 classifications for Type, Grade, Class, and Uses.
 - 1. **Additional Movement Capability:** Where additional movement capability is specified in Elastomeric Joint Sealant Data Sheet, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at time of installation and remain in compliance with other requirements of ASTM C 920 for Uses indicated.
- B. **Products:** Subject to compliance with requirements, provide one of the products specified in each Elastomeric Joint Sealant Data Sheet.

2.3 JOINT SEALANT BACKING

- A. **General:** Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. **Plastic Foam Joint Fillers:** Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
 - 2. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 2.5 pcf and tensile strength of 35 psi per ASTM D 1623, and with water absorption less than 0.02 g/cc per ASTM C 1083.
 - 3. Any material indicated above.
- C. **Elastomeric Tubing Joint Fillers:** Neoprene, butyl, EPDM or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to 26 deg. F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. **Bond-Breaker Tape:** Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.4 JOINT FILLERS FOR CONCRETE PAVING

- A. **General:** Provide joint fillers of thicknesses and widths indicated.

1. Bituminous Fiber Joint Filler: Preformed strips of composition below, complying with ASTM D 1751:
 - a. Asphalt saturated fiberboard.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
 3. Remove laitance and form release agents from concrete.

4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:
 1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - a. Do not leave gaps between ends of joint fillers.
 - b. Do not stretch, twist, puncture, or tear joint fillers.
 - c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.
- E. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 - a. Use masking tape to protect adjacent surfaces of recessed tooled joints.

3.4 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

3.6 ELASTOMERIC JOINT SEALANT DATA SHEET

- A. Elastomeric Joint Sealant Designation: One part Pourable Urethane Sealant

1. Base Polymer: Urethane.
2. Type: S (single component).
3. Grade: P (pourable).
4. Class: 25.
5. Use Related to Exposure: T (traffic).
6. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated.

- a. Use O Joint Substrates: Galvanized steel, concrete, ceramic tile.

7. Products:

- a. "NR-201 Urexpan", Pecora Corp.
 - b. "Vulkem 45", Memco.
 - c. "Sonolastic SL 1", Sonneborn Building Products Division.

- B. Elastomeric Joint Sealant Designation: Multi-part non-sag urethane sealant

1. Base Polymer: Urethane.
2. Type: M (Multi component).
3. Grade: NS (nonsag).
4. Class: 25.
5. Additional Movement Capability: 50 percent movement in extension and 50 percent in compression for a total of 100 percent movement.

6. Use Related to Exposure: NT (nontraffic).
7. Uses Related to Joint Substrates: M, G, A, and , as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Color anodized aluminum, aluminum coated with a high-performance coating, galvanized steel, ceramic tile.
8. Products:
 - a. "Dynatrol II", Pecora Corp.
 - b. "Vulkem 922", Mameco.
 - c. "Sonolastic NP2", Sonneborn Building Products Division.

C. Elastomeric Joint Sealant Designation: One part mildew resistant silicone

1. Base Polymer: Acid-curing silicone.
2. Type: S (single component).
3. Grade: NS (nonsag).
4. Class: 25.
5. Use Related to Exposure: NT (nontraffic).
6. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
 - a. Use O Joint Substrates: Coated glass, color anodized aluminum, aluminum coated with a high-performance coating, galvanized steel, brick, and ceramic tile.
7. Products:
 - a. "786 Mildew Resistant", Dow Corning.
 - b. "Sanitary 1700", GE Silicones.

D. Elastomeric Joint Sealant Designation: Acrylic-Emulsion Sealant

1. Base Polymer: Acrylic -Emulsion Sealant.
2. Type: S (single component).
3. Grade: NS (nonsag).
4. Class: 25.
5. Use Related to Exposure: NT (nontraffic).
6. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated
7. Products:
 - a. "AC-20," Pecora Corp.
 - b. "Sonolac," Sonneborn Building Products Div., ChemRex, Inc.
 - c. "Tremco Acrylic Latex 834," Tremco, Inc.

3.7 JOINT SEALANT SCHEDULE

JOINT SEALERS	DESCRIPTION OF JOINT CONSTRUCTION AND LOCATION WHERE SEALANT IS TYPICALLY APPLIED*.
---------------	---

One-Part Pourable Urethane Sealant	Exterior and interior joints in horizontal surfaces of concrete.
Multi-Part Nonsag Urethane Sealant	Exterior and interior joints in vertical surfaces of concrete; between metal and concrete or mortar; interior and exterior perimeter joints of metal frames in exterior walls; exterior overhead joints.
Acrylic-Emulsion Sealant	Interior joints in field-painted vertical and overhead surfaces at perimeter of hollow metal door and window frames; in gypsum drywall, concrete, and concrete masonry; and all other interior joints not indicated otherwise.

END OF SECTION 07920

SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Standard hollow metal doors and frames.
- B. Related Sections
 - 1. Division 4 Section "Unit Masonry Assemblies" for embedding anchors for hollow metal work into masonry construction.
 - 2. Division 8 Section "Door Hardware" for door hardware for hollow metal doors.
 - 3. Division 9 Sections "Painting" for field painting hollow metal doors and frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door design.
 - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.

9. Details of conduit and preparations for power, signal, and control systems.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification:
 1. For each type of exposed finish required, prepared on Samples of not less than **3 by 5 inches**.
 2. For the following items, prepared on Samples about **12 by 12 inches** to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow metal panels and glazing if applicable.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum **4-inch**- high wood blocking. Do not store in a manner that traps excess humidity.
 1. Provide minimum **1/4-inch** space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benchmark; a division of Therma-Tru Corporation.
 - 2. Deansteel Manufacturing Company, Inc.
 - 3. Habersham Metal Products Company.
 - 4. Kewanee Corporation (The).
 - 5. Mesker Door Inc.
 - 6. Pioneer Industries, Inc.
 - 7. Steelcraft; an Ingersoll-Rand company.
 - 8. Windsor Republic Doors.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum **A40** metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), **40Z** coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
- G. Grout: ASTM C 476, except with a maximum slump of **4 inches**, as measured according to ASTM C 143/C 143M.

- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - 3. Vertical Edges for Single-Acting Doors: Beveled edge.
 - a. Beveled Edge: 1/8 inch in 2 inches.
 - 4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
 - 5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick, end closures or channels of same material as face sheets.
 - 6. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless).
- C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Exterior Frames: Fabricated from metallic-coated steel sheet.
 - 1. Fabricate frames with mitered or coped corners.
 - 2. Fabricate frames as full profile welded unless otherwise indicated.

3. Frames for Level 2 Steel Doors: **0.053-inch-** thick steel sheet.

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than **0.042 inch** thick, with corrugated or perforated straps not less than **2 inches** wide by **10 inches** long; or wire anchors not less than **0.177 inch** thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than **0.042 inch** thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum **3/8-inch-** diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than **0.042 inch** thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than **2-inch** height adjustment. Terminate bottom of frames at finish floor surface.

2.6 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.7 ACCESSORIES

A. Grout Guards: Formed from same material as frames, not less than **0.016 inch** thick.

2.8 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117 .

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum **3/4 inch** beyond edge of door on which astragal is mounted.
- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than **18 inches** from top and bottom of frame. Space anchors not more than **32 inches** o.c. and as follows:
 - 1) Two anchors per jamb up to **60 inches** high.
 - 2) Three anchors per jamb from **60 to 90 inches** high.
 - 3) Four anchors per jamb from **90 to 120 inches** high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each **24 inches** or fraction thereof above **120 inches** high.
 - b. Stud-Wall Type: Locate anchors not more than **18 inches** from top and bottom of frame. Space anchors not more than **32 inches** o.c. and as follows:
 - 1) Three anchors per jamb up to **60 inches** high.
 - 2) Four anchors per jamb from **60 to 90 inches** high.
 - 3) Five anchors per jamb from **90 to 96 inches** high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each **24 inches** or fraction thereof above **96 inches** high.
 - 5) Two anchors per head for frames above **42 inches** wide and mounted in metal-stud partitions.
 - c. Compression Type: Not less than two anchors in each jamb.
 - d. Postinstalled Expansion Type: Locate anchors not more than **6 inches** from top and bottom of frame. Space anchors not more than **26 inches** o.c.
 6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

- E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."
 - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8 .
 - 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 - 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 - 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 16 Sections.

2.9 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus **1/16 inch**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 2. Alignment: Plus or minus **1/16 inch**, measured at jambs on a horizontal line parallel to plane of wall.
 3. Twist: Plus or minus **1/16 inch**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 4. Plumbness: Plus or minus **1/16 inch**, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
 9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus **1/16 inch**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus **1/16 inch**, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus **1/16 inch**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus **1/16 inch**, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: **1/8 inch** plus or minus **1/16 inch**.
 - b. Between Edges of Pairs of Doors: **1/8 inch** plus or minus **1/16 inch**.
 - c. Between Bottom of Door and Top of Threshold: Maximum **3/8 inch**.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum **3/4 inch**.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08110

SECTION 08711 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

- 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Other doors to the extent indicated.
- 2. Cylinders for doors specified in other Sections.
- 3. Electrified door hardware.

- B. Related Sections include the following:

- 1. Division 8 Section "Steel Doors and Frames" for astragals provided as part of a fire-rated labeled assembly and for door silencers provided as part of the frame.

- C. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1.3 SUBMITTALS

- A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings: Details of electrified door hardware, indicating the following:

- 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. System schematic.
 - b. Point-to-point wiring diagram.
 - c. Riser diagram.
 - d. Elevation of each door.
- 2. Detail interface between electrified door hardware and fire alarm system.

- C. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
 - 1) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- D. Product Certificates: Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.
1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
1. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, indicating current products comply with requirements.

- G. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 1.
- H. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 1. Electrified Door Hardware Supplier Qualifications: An experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
 - a. Engineering Responsibility: Prepare data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- C. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
 - 1. Electrified Door Hardware Qualifications: Experienced in providing consulting services for electrified door hardware installations.
- D. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.
- E. Regulatory Requirements: Comply with provisions of the following:
 - 1. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1, as follows:

- a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
- b. Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
 - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.

2. NFPA 101: Comply with the following for means of egress doors:

- a. Latches, Locks, and Exit Devices: Not more than 15 lbf 67 N to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
- b. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
- c. Thresholds: Not more than 1/2 inch high.

3. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

F. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.

G. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to electrified door hardware including, but not limited to, the following:

- 1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
- 2. Review sequence of operation for each type of electrified door hardware.
- 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- 4. Review required testing, inspecting, and certifying procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices.
- C. WARRANTY
- D. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- E. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of operators and door hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- F. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.
- G. Warranty Period for Electromagnetic Locks: Five years from date of Substantial Completion.
- H. Warranty Period for Manual Closers: 10 years from date of Substantial Completion.

1.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies as used in the manufacture and installation of original products.

1.8 EXTRA MATERIALS

- A. Furnish full-size units of door hardware described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hardware: one each passage latch sets, keyed lock sets, lock cylinder
2. Electrical Parts: one each magnetic hold open, operator, actuator, strike

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section, and the Door Hardware Schedule at the end of Part 3.
 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturer's products, products equivalent in function and comparable in quality to named products complying with BHMA standard referenced.
 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

2.2 HINGES AND PIVOTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hinges:
 - a. Baldwin Hardware Corporation (BH).
 - b. Bommer Industries, Inc. (BI).
 - c. Hagger Companies (HAG).
 - d. Lawrence Brothers, Inc. (LB).
 - e. McKinney Products Company; Div. of ESSEX Industries, Inc. (MCK).
 - f. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
 - g. Stanley Commercial Hardware; Div. of The Stanley Works (STH).
- B. Standards: Comply with the following:
 1. Butts and Hinges: BHMA A156.1.
 2. Template Hinge Dimensions: BHMA A156.7.

- C. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- D. Hinge Weight: Unless otherwise indicated, provide the following:
 - 1. Entrance Doors: Heavy-weight hinges.
 - 2. Doors with Closers: Antifriction-bearing hinges.
 - 3. Interior Doors: Standard-weight hinges.
- E. Hinge Base Metal: Unless otherwise indicated, provide the following:
 - 1. Exterior Hinges: Stainless steel, with stainless-steel pin.
 - 2. Interior Hinges: Steel, with steel pin.
 - 3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
- F. Hinge Options: Comply with the following where indicated in the Door Hardware Schedule or on Drawings:
 - 1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
 - a. Outswinging exterior doors.
 - b. Outswinging corridor doors with locks.
 - 2. Corners: Square.
- G. Fasteners: Comply with the following:
 - 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - 2. Wood Screws: For wood doors and frames.
 - 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
 - 4. Screws: Phillips flat-head screws; machine screws (drilled and tapped holes) for metal doors, wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

2.3 LOCKS AND LATCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mechanical Locks and Latches:
 - a. Schlage (no substitutions- matching existing system)
 - 2. Electromagnetic Latches:
 - a. Locknetics Security Engineering; a Harrow Company (LSE). (no substitutions- matching existing system)

B. Standards: Comply with the following:

1. Bored Locks and Latches: BHMA A156.2.
2. Mortise Locks and Latches: BHMA A156.13.
3. Interconnected Locks and Latches: BHMA A156.12.
4. Auxiliary Locks: BHMA A156.5.
5. Push-Button Combination Locks: BHMA A156.2.
6. Electromagnetic Locks: BHMA A156.23.
7. Delayed-Egress Locks: BHMA A156.24.
8. Exit Locks: BHMA A156.5.

C. Bored Locks: BHMA Grade 1; Series 4000.

D. Certified Products: Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

E. Lock Trim: Comply with the following:

1. Lever: Wrought, forged, or cast.
2. Escutcheon (Rose): Wrought, forged, or cast.
3. Dummy Trim: Match lever lock trim and escutcheons.
4. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

F. Lock Functions: Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:

1. Bored Locks: BHMA A156.2

G. Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Deadbolts: Minimum 1-inch bolt throw.

H. Rabbeted Doors: Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

I. Backset: 2-3/4 inches, unless otherwise indicated.

2.4 ELECTRIFIED LOCKS AND LATCHES

A. Electromagnetic Locks: Electrically powered locks of strength and configuration indicated; with electromagnet attached to frame and strike plate attached to door. Comply with the following:

1. Strength Ranking: 1500 lbf as tested according to BHMA A156.23.
2. Inductive Kickback: Not more than 53-V peak voltage, as tested according to BHMA A156.23.

3. Residual Magnetism: Not more than 0 lbf to separate door from magnet, as tested according to BHMA A156.23.

2.5 CYLINDERS AND KEYING

- A. Owner will provide ASSA cylinders for locksets.

2.6 STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

2.7 CLOSERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Surface-Mounted Closers:
 - a. LCN Closers; an Ingersoll-Rand Company (LCN). (required to match existing bldg.)
- C. Standards: Comply with the following:
 1. Closers: BHMA A156.4.
- D. Surface Closers: BHMA Grade 1
- E. Certified Products: Provide door closers listed in BHMA's "Directory of Certified Door Closers."
- F. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.8 PROTECTIVE TRIM UNITS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Metal Protective Trim Units:

- a. Baldwin Hardware Corporation (BH).
- b. Hager Companies (HAG).
- c. Ives: H. B. Ives (IVS).
- d. NT Quality Hardware; an Ingersoll-Rand Company (NTQ).
- e. Rockwood Manufacturing Company (RM).
- f. Triangle Brass Manufacturing Company, Inc. (TBM).

C. Standard: Comply with BHMA A156.6.

D. Materials: Fabricate protection plates from the following:

1. Stainless Steel: 0.050 inch thick; beveled top and 2 sides.

E. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.

F. Furnish protection plates sized 1-1/2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in Door Hardware Schedule.

2.9 STOPS AND HOLDERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Baldwin Hardware Corporation (BH).
2. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
3. Hager Companies (HAG).
4. Ives: H. B. Ives (IVS).
5. LCN Closers; an Ingersoll-Rand Company (LCN).
6. Norton Door Controls; Div. of Yale Security Inc. (NDC).
7. NT Quality Hardware; an Ingersoll-Rand Company (NTQ).
8. Rockwood Manufacturing Company (RM).
9. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
10. Triangle Brass Manufacturing Company, Inc. (TBM).

B. Standards: Comply with the following:

1. Stops and Bumpers: BHMA A156.16.
2. Mechanical Door Holders: BHMA A156.16.
3. Electromagnetic Door Holders: BHMA A156.15.
4. Combination Overhead Holders and Stops: BHMA A156.8.
5. Door Silencers: BHMA A156.16.

C. Stops and Bumpers: BHMA Grade 1.

D. Floor Stops: For doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.

1. Where floor or wall stops are not appropriate, provide overhead holders.

2.10 MISCELLANEOUS DOOR HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Baldwin Hardware Corporation (BH).
 2. Hager Companies (HAG).
 3. Ives: H. B. Ives (IVS).
 4. NT Quality Hardware; an Ingersoll-Rand Company (NTQ).
 5. Rockwood Manufacturing Company (RM).
 6. Triangle Brass Manufacturing Company, Inc. (TBM).
- B. Standard: Comply with the following:
 1. Auxiliary Hardware: BHMA A156.16.
 2. Exit Alarms: BHMA A156.5.
- C. Auxiliary Hardware: BHMA Grade 1, unless otherwise indicated.

2.11 FABRICATION

- A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 1. Manufacturer's identification will be permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 2. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a. Mortise hinges to doors.
 - b. Strike plates to frames.

- c. Closers to doors and frames.
- 3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:
 - a. Surface hinges to doors.
 - b. Closers to doors and frames.
 - c. Surface-mounted exit devices.
- 4. Spacers or Sex Bolts: For through bolting of hollow metal doors.
- 5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.12 FINISHES

- A. Standard: Comply with BHMA A156.18.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. BHMA Designations: Comply with base material and finish requirements indicated by the following:
 - 1. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
 - 2. BHMA 630: Satin stainless steel, over stainless-steel base metal.
 - 3. BHMA 652: Satin chromium plated over nickel, over steel base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.

- B. Wood Doors: Comply with DHI A115-W series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

- C. Key Control System: Comply with SLCC system.

- D. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening.
2. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware. Peninsula

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 3. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point **3 inches** from the latch, measured to the leading edge of the door.
- B. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:
1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
 2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
 3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.8 DOOR HARDWARE SCHEDULE

NO.	QTY.	ITEM	MFG	MODEL	STYLE/SIZE	FINISH
1		Corridor doors (1-hour rated)				
	3 Ea	Hinges	Hager	AB700	4 ½ "x 4 "	26D
	1 Ea	Lockset	Schlage*	D94PD	Rhodes	26D
	1 Ea	Closer	LCN*	4040	H-Cush	AL
	1 Ea	Kickplate	Quality	No. 48	10"	32D
	1 Ea	Stop	Quality	W302	-----	32D

Spectrum Engineers
DFCM #05238660

BUSINESS BUILDING CHILLER REPLACEMENT
SLCC Redwood Campus

1 Set Smoke Seal National Guard 2525

2 Office (non rated)

3 Ea	Hinges	Hager	AB700	4 1/2 "x 4 "	26D
1 Ea	Lockset	Schlage*	D50PD	Rhodes	26D
1 Ea	Stop	Quality	W302	-----	32D

END OF SECTION 08711

SECTION 09900 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes surface preparation and field painting of the following:
 - 1. Exposed interior items and surfaces.
 - 2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
- C. Unless otherwise noted, do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Prefinished items include the following factory-finished components:
 - a. Architectural woodwork and casework.
 - b. Finished mechanical and electrical equipment.
 - c. Elevator entrance doors and frames.
 - d. Elevator equipment.
 - e. Light fixtures.
 - f. Distribution cabinets.
 - 2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Furred areas.
 - b. Ceiling plenums.
 - c. Utility tunnels, except for gas pipe, which shall be painted.
 - d. Pipe spaces.

- e. Duct shafts.
 - 3. Finished metal surfaces include the following:
 - a. Anodized aluminum.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Architectural Copper.
 - e. Architectural Bronze and brass.
 - 4. Operating parts include moving parts of operating equipment and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
 - 5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- D. Related Sections include the following:
- 1. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.
 - 2. Division 6 Section "Interior Architectural Woodwork" for shop priming interior architectural woodwork.
 - 3. Division 8 Section "Steel Frames" for shop priming steel frames.
 - 4. Division 9 Section "Gypsum Board Assemblies" for surface preparation for gypsum board.

1.3 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
- 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 - 2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
 - 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 - 4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
 - 5. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. Product Data: For each paint system specified. Include block fillers and primers.

1. **Material List:** Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. **Manufacturer's Information:** Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
 3. **Certification** by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
- B. **Samples for Initial Selection:** Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.
1. After color selection, the Architect will furnish color chips for surfaces to be coated.
- C. **Samples for Verification:** Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.
 3. Submit Samples on the following substrates for the Architect's review of color and texture only:
 - a. **Concrete:** Provide two 4-inch- square samples for each color and finish.
 - b. **Ferrous Metal:** Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.
- D. **Qualification Data:** For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. **Applicator Qualifications:** Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
- B. **Source Limitations:** Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
- C. **Benchmark Samples (Mockups):** Provide a full-coat benchmark finish sample of each type of coating and substrate required on the Project. Comply with procedures specified in PDCA P5. Duplicate finish of approved prepared samples.
1. The Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.

- a. Wall Surfaces: Provide samples on at least 100 sq. ft. of wall surface.
 - b. Small Areas and Items: The Architect will designate an item or area as required.
2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface according to the Schedule or as specified. Provide required sheen, color, and texture on each surface.
 - a. After finishes are accepted, the Architect will use the room or surface to evaluate coating systems of a similar nature.
3. Final approval of colors will be from job-applied samples.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Manufacturer's stock number and date of manufacture.
 4. Contents by volume, for pigment and vehicle constituents.
 5. Thinning instructions.
 6. Application instructions.
 7. Color name and number.
 8. VOC content.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.
- C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
 1. Quantity: Furnish the Owner with an additional 5 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in the paint schedules.
 1. PPG Industries, Inc. (PPG).
 2. Pratt & Lambert, Inc. (P & L).
 3. Sherwin-Williams Co. (S-W).

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
- C. Colors: Provide custom colors of the finished paint systems to match the Architect's samples.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Provide barrier coats over incompatible primers or remove and reprime.
 - 2. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
 - a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of SSPC-SP 10.
 - b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

- c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
- D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 - 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 - 8. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer on metal surfaces that have been shop primed and touchup painted.

3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
- F. Mechanical items to be painted include, but are not limited to, the following:
1. Piping, pipe hangers, and supports.
 2. Roof Top Units
 3. Insulation.
 4. Accessory items.
- G. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- H. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- I. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
1. Provide satin finish for final coats.

- J. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 INTERIOR PAINT SCHEDULE

- A. Concrete Masonry Units: Provide the following finish systems over interior concrete masonry block units:
 - 1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a block filler.
 - a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 5.0 mils.
 - 1) PPG:6-7 Speedhide Interior/Exterior Masonry Latex Block Filler.
 - 2) P & L:Z 98 Pro-Hide Plus Latex Block Filler.
 - b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
 - 1) PPG:89 Line Manor Hall Eggshell Latex Wall and Trim Enamel.
 - 2) P & L:Z/F 4000 Series Accolade Interior Velvet.
- B. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:

1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) PPG:17-10 Quick-Drying Interior Latex Primer-Sealer.
 - 2) P & L:Z/F 1004 Suprime "4" Interior Latex Wall Primer.
 - b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.
 - 1) PPG:89 Line Manor Hall Eggshell Latex Wall and Trim Enamel.
 - 2) P & L:Z/F 4000 Series Accolade Interior Velvet.

C. Ferrous Metal: Provide the following finish systems over ferrous metal:

1. Semigloss, Alkyd-Enamel Finish: One finish coat over an enamel undercoater and a primer.
 - a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.
 - 1) PPG:6-208 Speedhide Interior/Exterior Rust Inhibitive Steel Primer.
 - 2) P & L:S 4551 Tech-Gard High Performance Rust Inhibitor Primer.
 - 3) S-W:Kem Kromik Metal Primer B50N2/B50W1.
 - b. Undercoat: Alkyd, interior enamel undercoat or semigloss, interior, alkyd-enamel finish coat, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.
 - 1) PPG:6-6 Speedhide Interior Quick-Drying Enamel Undercoater.
 - 2) P & L:S/D 1011 Suprime "11" Interior Alkyd Wood Primer.
 - 3) S-W:ProMar 200 Interior Alkyd Semi-Gloss Enamel B34W200.
 - c. Finish Coat: Odorless, semigloss, alkyd, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.4 mils.
 - 1) PPG:27 Line Wallhide Low Odor Interior Enamel Wall and Trim Semi-Gloss Oil.
 - 2) P & L:S/D 5700 Cellu-Tone Alkyd Satin Enamel.
 - 3) S-W:Classic 99 Interior/Exterior Semi-Gloss Alkyd Enamel A-40 Series.

END OF SECTION 09900

SECTION 15010 - BASIC MECHANICAL REQUIREMENTS

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 15.
- B. This section applies to all Division 15 specification sections.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
 - 1. Submittals.
 - 2. Coordination drawings.
 - 3. Record documents.
 - 4. Rough-ins.
 - 5. Mechanical installations.
 - 6. Cutting and patching.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 15 Section "BASIC MECHANICAL MATERIALS AND METHODS," for materials and methods common to the remainder of Division 15, plus general related specifications including:
 - a. Access to mechanical installations.
 - b. Excavation for mechanical installation utilities.

1.3 GOVERNING REGULATIONS AND AUTHORITIES

- A. Regulations include laws, ordinances, codes, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the work, govern the execution of the work embodied in the contract documents, and the interpretation of the contract documents.
- B. Applicable codes and documents to this project are, but not limited to, the following:
 - 1. 2003 International Building Code - (with Utah amendments)
 - 2. 2003 International Mechanical Code - (with Utah amendments)
 - 3. 2003 International Plumbing Code - (with Utah amendments)
 - 4. National Electrical Code - current edition (2002)

5. International Fire Code (2003).
6. International Refrigeration Code (2003).
7. DFCM Design Criteria - current edition.

1.4 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Section "SUBMITTALS", and as outlined below.
 1. By description, catalog number and manufacturer's name standards of quality have been established for certain manufactured equipment items and specialties which are to be furnished by this Division. Substitute products of equal or better quality may only be proposed for use if specifically named in the specifications or given written approval prior to bidding. Requests for substitution shall be made in accordance with the General Provisions.
 2. Within 21 days after the date of award of contract, and before commencement of work, a complete schedule of all equipment and materials proposed for installation shall be submitted.
 3. Submittal data for Division 15 shall be submitted arranged in a three-ring binder. Binder shall have a complete index with equipment listed in the same sequence as the sections in the specifications. Identify the equipment submitted with drawings, schedule number, and specification paragraph number.
 4. Submittals shall include, but not be limited to the following:
 - a. Scheduled Equipment Items
 - b. Vibration Elimination Devices
 - c. Seismic Restraint System
 - d. Valves
 - e. Insulation
 - f. Automatic Temperature Controls
 - g. Automation System
 - h. Certificates of Guarantee
 5. Description of equipment shall include sizes, capacities, operating characteristics, brand names, motor horsepower, accessories, materials gauges, manufacturer's maintenance instructions and other pertinent information required to establish quality of the products. List on the front of catalogs the page number referring to submitted items. Underline applicable data on the indicated pages. Where proposed equipment size varies from equipment first named, Contractor shall specifically call Architect's attention to that fact in writing at the time of submission of data.
 6. All submittal data shall be turned over to the Architect at one time. No consideration will be given to partial submittals.
 7. After engineering review, the Contractor may proceed to place an order for such item of equipment. However, actual fabrication by manufacturer may not commence until complete and accurate shop drawings have been submitted to Architect and have received his reviewed stamp and signature.

8. A copy of the complete contract specification for the item, including motor requirements and any specific details of construction, shown on the drawings shall be sent to the factory furnishing such item, at the time the order is placed to avoid unnecessary errors.
 9. The Contractor should protect himself with the supplier of alternate named equipment. Should Contractor submit on any item of equipment other than first named equipment in the specification and if alternate equipment is rejected or disapproved by the Architect for any of the reasons stated above, the Contractor shall be required to resubmit on first named equipment.
 10. All items other than first named specified equipment shall show and state all exceptions and deviations taken and shall include design calculations.
 11. The Contractor shall review the submittals prior to submission to make sure that submittals are complete in all details. Contractor shall verify equipment dimensions to fit the spaces provided with sufficient clearance for servicing the equipment. Submittals will not be reviewed which do not bear the Contractor's notation that such checking has been made.
 12. Equipment submittal shall show the proper arrangements to suit installation and maintenance such as motor location, access doors, filter removal, piping connections, etc.
 13. Equipment submittal sheets shall be clearly marked indicating equipment symbol and exact selection of proposed equipment.
 14. Review and acceptance of submittal does not relieve the Contractor of responsibility for fulfilling the contract requirements. Review of the submittal shall not change the contract requirements. Items not covered in the accepted submittal or items incorrectly covered but not recognized or identified shall not be used contrary to the contract documents.
 15. Verify electrical characteristics of all equipment with Division 16 before ordering any equipment.
- B. Increase, by the quantity listed below, the number of mechanical related shop drawings, product data, and samples submitted, to allow for required distribution plus one copy of each submittal required, which will be retained by the Mechanical Consulting Engineer.
1. Shop Drawings - Initial Submittal: 1 additional blue- or black-line prints.
 2. Shop Drawings - Final Submittal: 1 additional blue- or black-line prints.
 3. Product Data: 1 additional copy of each item.
 4. Samples: 1 additional set.
- C. Additional copies may be required by individual sections of these Specifications.

1.5 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 Section "COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and

coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of piping, equipment, and materials.
Include the following:
 - a. Clearances for installing and maintaining insulation.
 - b. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - c. Equipment connections and support details.
 - d. Exterior wall and foundation penetrations.
 - e. Fire-rated wall and floor penetrations.
 - f. Sizes and location of required concrete pads and bases.
 - g. Valve stem movement.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.6 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 1 Section "CONTRACT CLOSEOUT." In addition to the requirements specified in Division 1, indicate the following installed conditions:
 1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 15 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.8 WARRANTIES

- A. In addition to guarantee specified in General Conditions, guarantee heating and plumbing systems to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.
- B. That the circulation of water shall be complete and even.
- C. That all pipes, conduit, and connections shall be free from foreign matter and pockets and that all other obstructions to the free passage of water, liquid and vent shall be removed.
- D. That all devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system.
- E. All equipment and the complete system shall be guaranteed for a period of one year from the date of Substantial Completion. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period.
- F. Any failure that disables a heating or cooling system shall have repairs completed within 24 hours. If repair parts are not available in local stock, they shall be shipped via air freight at no charge to the owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Arrange equipment with factory panels, conduits, piping, etc. to allow proper access to equipment. Comply with clearances required by the National Electric Code.

PART 3 - EXECUTION

3.1 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.2 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
12. Completely clean all mechanical equipment and systems of dirt, dust, debris and overspray at the time of substantial completion.
13. All factory-authorized equipment start-ups shall be witnessed by the Owner's representative, unless written exception is given. Any equipment start-ups completed without Owner's representative being present shall be repeated.

3.3 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
 1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
 - 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 - 1. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
 - a. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of "experienced Installer."
 - 2. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
 - a. Refer to Division 1 Section "DEFINITIONS AND STANDARDS" for definition of "experienced Installer."

END OF SECTION 15010

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to all Division 15 specification sections.

1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Concrete base construction requirements.
 - 3. Escutcheons.
 - 4. Dielectric fittings.
 - 5. Flexible connectors.
 - 6. Mechanical sleeve seals.
 - 7. Equipment nameplate data requirements.
 - 8. Labeling and identifying mechanical systems and equipment is specified in Division 15 Section "Mechanical Identification."
 - 9. Nonshrink grout for equipment installations.
 - 10. Field-fabricated metal and wood equipment supports.
 - 11. Installation requirements common to equipment specification sections.
 - 12. Mechanical demolition.
 - 13. Cutting and patching.
 - 14. Touchup painting and finishing.
 - 15. Accessibility.
- B. Pipe and pipe fitting materials are specified in Division 15 piping system Sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces, mechanical equipment rooms and utility tunnels.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. NP: Nylon plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 2. EPDM: Ethylene propylene diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- B. Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- C. Welder Certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

1.5 COORDINATION DRAWINGS

- A. General: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Have coordination drawings available at job site for coordination. Include the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - 4. Equipment and accessory service connections and support details.
 - 5. Exterior wall and foundation penetrations.
 - 6. Fire-rated wall and floor penetrations.
 - 7. Sizes and location of required concrete pads and bases.

8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- B. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.6 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.
- C. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code -- Steel."
- D. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.

- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.
- H. Coordinate connection of electrical services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dielectric Unions:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Eclipse, Inc.; Rockford-Eclipse Div.
 - d. Epco Sales Inc.
 - e. Hart Industries International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
 - 2. Dielectric Flanges:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Epco Sales Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - 3. Dielectric-Flange Insulating Kits:
 - a. Calpico, Inc.
 - b. Central Plastics Co.

4. Metal, Flexible Connectors:
 - a. ANAMET Industrial, Inc.
 - b. Central Sprink, Inc.
 - c. Flexicraft Industries.
 - d. Flex-Weld, Inc.
 - e. Grinnell Corp.; Grinnell Supply Sales Co.
 - f. Hyspan Precision Products, Inc.
 - g. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
 - h. Mercer Rubber Co.
 - i. Metraflex Co.
 - j. Proco Products, Inc.
 - k. Uniflex, Inc.
5. Mechanical Sleeve Seals:
 - a. Calpico, Inc.
 - b. Metraflex Co.
 - c. Thunderline/Link-Seal.

2.2 PIPE AND PIPE FITTINGS

- A. All pipe and pipe fittings shall be American made and clearly labeled as such.
- B. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods.
- C. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
 3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
 4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
 5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- F. Brazing Filler Metals: AWS A5.8.
1. BCuP Series: Copper-phosphorus alloys.
 2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements: Manufacturer's standard solvent cements for the following:
1. ABS Piping: ASTM D 2235.
 2. CPVC Piping: ASTM F 493.
 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.
- J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- K. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
1. Sleeve: ASTM A 126, Class B, gray iron.
 2. Followers: ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 536 ductile iron.
 3. Gaskets: Rubber.
 4. Bolts and Nuts: AWWA C111.
 5. Finish: Enamel paint.

2.4 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.5 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2-Inch NPS (DN50) and Smaller: Threaded.
 - 2. 2-1/2-Inch NPS (DN65) and Larger: Flanged.
 - 3. Option for 2-1/2-Inch NPS (DN65) and Larger: Grooved for use with keyed couplings.
- B. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- C. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

2.7 PIPING SPECIALTIES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
 - 1. Steel Sheet Metal: 0.0239-inch (0.6-mm) minimum thickness, galvanized, round tube closed with welded longitudinal joint.

2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
- B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 2. OD: Completely cover opening.
 3. Cast Brass: One piece, with set screw.
 - a. Finish: Polished chrome-plate.
 4. Cast Brass: Split casting, with concealed hinge and set screw.
 - a. Finish: Polished chrome-plate.
 5. Stamped Steel: One piece, with set screw and chrome-plated finish.
 6. Stamped Steel: One piece, with spring clips and chrome-plated finish.
 7. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
 8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
 9. Stamped Steel: Split plate, with exposed-rivet hinge, set screw, and chrome-plated finish.
 10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
 11. Cast-Iron Floor Plate: One-piece casting.

2.8 GROUT

- A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 15 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.

- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping close to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch (25-mm) clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's written instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- N. Sleeves are not required for core drilled holes.
- O. Permanent sleeves are not required for holes formed by PE removable sleeves.
- P. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor

- slab as required to secure clamping ring if ring is specified.
2. Build sleeves into new walls and slabs as work progresses.
 3. Install sleeves large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).
 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants.
 5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- R. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) in diameter and larger.
 3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- S. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- T. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 7 Section "Firestopping" for materials.
- U. Verify final equipment locations for roughing-in.
- V. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- W. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - c. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 6. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- X. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
 2. Install flanges, in piping 2-1/2-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- G. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors.

3.3 PAINTING AND FINISHING

- A. Refer to Division 9 Section "Painting" for paint materials, surface preparation, and application of paint.
- B. Apply paint to exposed piping according to the following, unless otherwise indicated:
 - 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 - 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
- C. Do not paint piping specialties with factory-applied finish.
- D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."
- B. Reinforce with #3 bars at 12" O.C. both ways and anchor to floor with reinforcing steel unless otherwise indicated. Chamfer top edge and corners.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.7 DEMOLITION

- A. Disconnect, demolish, and remove Work specified in Division 15 Sections.
- B. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches (50 mm) beyond face of adjacent construction. Cap and patch surface to match existing finish.
- E. Removal: Remove indicated equipment from Project site.
- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.8 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.9 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 15050

SECTION 15055 - MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes basic requirements for motors. It includes motors that are factory-installed as part of equipment and appliances as well as field-installed motors.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70, "National Electrical Code."
- B. NRTL Listing: Provide NRTL listed motors.
 - 1. Term "Listed": As defined in "National Electrical Code," Article 100.
- C. Comply with NEMA MG 1, "Motors and Generators."

PART 2 - PRODUCTS

2.1 MOTORS, GENERAL

- A. General: Requirements below apply to motors covered by this Section except as otherwise indicated.
- B. Normally motors larger than 1/2 HP: Polyphase.
- C. Normally motors 1/2 HP and smaller: Single-phase.
- D. Frequency Rating: 60 Hz.
- E. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):
 - 1. 120 V Circuit: 115 V - motor rating.
 - 2. 208 V Circuit: 200 V - motor rating.
 - 3. 240 V Circuit: 230 V - motor rating.
 - 4. 480 V Circuit: 460 V - motor rating.

- F. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will operate in service factor range when supply voltage is within 10 percent of motor voltage rating.
- G. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity. Provide NEMA torque curve for each motor provided and included in O & M manual.
- H. Temperature Rise: Based on 40 deg C ambient except as otherwise indicated.
- I. Enclosure: Open dripproof, unless otherwise specified or indicated.

2.2 POLYPHASE MOTORS

- A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.
- B. NEMA Design Letter Designation: "B."
- C. Energy Efficient Motors: Premium efficient equal to or greater than that stated for that type and rating of motor.
- D. Variable Speed Motors for Use With Solid-State Drives: Premium efficient, squirrel-cage induction, design B units with ratings, characteristics, and features coordinated with and approved by drive manufacturer. NEMA MG-1 Part 31 definite purpose inverted poly phase.
- E. Internal Thermal Overload Protection For Motors: For motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.
- F. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application. Use insulated bearings and shift grounding on all variable speed motors.
- G. Rugged Duty Motors: Totally enclosed with 1.25 minimum service factor. Provide motors with regreasable bearings and equipped with capped relief vents. Insulate windings with nonhygroscopic material. External finish shall be chemical resistant paint over corrosion resistant primer. Provide integral condensate drains.
- H. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: The following requirements apply to field-installed motors.
- B. Install motors in accordance with manufacturer's published instructions and the following:
 - 1. Direct Connected Motors: Mount securely in accurate alignment.
 - 2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

3.2 COMMISSIONING

- A. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which the motor is a part.
- B. Report unusual conditions.
- C. Correct deficiencies of field-installed units.

END OF SECTION 15055

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.
- B. Related Sections include the following:
 - 1. Division 15 Section "Mechanical Vibration and Seismic Controls" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- C. Design seismic restraint hangers and supports for piping and equipment.
- D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.
 - 1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Hangers:
 - a. AAA Technology and Specialties Co., Inc.
 - b. B-Line Systems, Inc.
 - c. Carpenter & Patterson, Inc.
 - d. Empire Tool & Manufacturing Co., Inc.
 - e. Globe Pipe Hanger Products, Inc.
 - f. Grinnell Corp.
 - g. GS Metals Corp.
 - h. Michigan Hanger Co., Inc.
 - i. National Pipe Hanger Corp.
 - j. PHD Manufacturing, Inc.
 - k. PHS Industries, Inc.
 - l. Piping Technology & Products, Inc.
 - 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. GS Metals Corp.
 - d. Michigan Hanger Co., Inc.; O-Strut Div.
 - e. National Pipe Hanger Corp.
 - f. Thomas & Betts Corp.

- g. Unistrut Corp.
- h. Wesanco, Inc.
- 3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. PHS Industries, Inc.
 - d. Pipe Shields, Inc.
 - e. Rilco Manufacturing Co., Inc.
 - f. Value Engineered Products, Inc.
- 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 - 1. Coatings: Galvanized, Metallic.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
 - 1. Coatings: Galvanized, Metallic.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi (690-kPa) minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 - 2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 - 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 5. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).
 - 2. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30 (DN15 to DN750).
 - 3. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.
 - 4. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN50 to DN1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 5. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb (340 kg).
 - b. Medium (MSS Type 32): 1500 lb (675 kg).
 - c. Heavy (MSS Type 33): 3000 lb (1350 kg).
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 1. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual
- F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- K. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 - 2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN200 to DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN400 to DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
 - 5. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
 - 6. Insert Material: Length at least as long as protective shield.
 - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).



- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SECTION 15071 - MECHANICAL VIBRATION AND SEISMIC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is part of each Division-15 section making reference to seismic and vibration control products specified herein.

1.2 SEISMIC AND VIBRATION CONTROL

- A. General: Division 15 shall be responsible for purchasing and installing vibration isolators, flexible connections, rigid steel frames, concrete inertia bases, anchors, inserts, hangers and attachments and seismic bracing and snubbers as required for seismic control and prevention of the transmission of vibration for both isolated and non-isolated systems.
- B. All mechanical equipment shall be designed for Seismic Zone III as per the Uniform Building Code.
- C. Reference Standards: The work shall comply to the following standards:
 - 1. International Building Code, 2003 edition
 - 2. NFPA Bulletin 90A, current edition
 - 3. Seismic Restraint Manual Guidelines for Mechanical Systems (SMACNA) latest edition that complies with 2003 International Building Code.
 - 4. Bridge Bearing Specifications
- D. Design Parameters: Refer to the 2003 International Building Code.
- E. Approved Manufacturers:
 - 1. In order to insure that the requirements of the project are achieved, the Contractor must secure the services of a manufacturer or supplier who has proven capabilities of dealing effectively with vibration characteristics, effects and criteria and can provide facilities and capabilities for measuring, evaluating and designing for seismic disturbances.
 - 2. Manufacturers approved for use are:
 - a. Mason Industries, Inc.
 - b. Amber/Booth Company.
 - c. Vibration Eliminator Co.
 - 3. The Manufacturer's responsibilities shall include designing and providing all vibration isolators and seismic restraints. He shall also be responsible for the proper installation of these components. Periodic inspections to

the job site will be made as required. He shall make a final inspection and submit a report to the Architect certifying compliance to these specifications, drawings and related standards. Provide submittals as specified.

- F. Submittals: Submittal data prior to fabrication, shall include but not be limited to the following:
1. Complete engineering calculations and shop drawings for all vibration and seismic requirements for all equipment, piping and ductwork.
 2. The Utah State professional stamp of the Engineer who is responsible for the design and operation of the Vibration and Seismic System.
 3. The type, size, and deflection of each isolator proposed for items in this specification and on the drawings.
 4. Details for all the isolators and seismic bracing with snubbers proposed for items in this specification and on the drawings.
 5. Details for steel frames and concrete inertia bases to be used in conjunction with the isolation and seismic restraint of the items in this specification and drawings.
 6. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing and snubber.
 7. The size, loading and location of pipe and duct supports with an as-built plan or complete description of the system.
- G. Vibration Isolation:
1. All mechanical equipment 1 HP, and over unless otherwise noted, shall be isolated from the structure by means of resilient vibration and noise isolators designed and supplied by the Seismic and Vibration Control Manufacturer. Piping and ductwork connected to vibrating equipment shall be isolated from the structure as required to prevent vibration transmission. Isolation equipment, hangers, connections, and other isolating devices shall be designed and installed to prevent transmission of vibration to the structure from the mechanical equipment or any of the associated piping and ductwork.
 2. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases unless the equipment manufacturer certified direct attachment capability. The steel frames and bases on isolated equipment shall be provided by the Seismic and Vibration Control Manufacturer.
- H. Vibration isolators shall be provided as follows and as otherwise indicated:
1. Floor mounted pumps shall be mounted on Type P neoprene pads.
 2. Suspended exhaust fans and air handling units shall be suspended on Type D spring hangers with neoprene element.
 3. Roof mounted exhaust fans shall have spring isolators with integral seismic restraint.
 4. Isolate all water piping that is connected to vibration isolated equipment, for a distance of at least 50 feet from the equipment. Isolators shall be Type D spring hangers.
 5. Isolate all piping in chiller room. Isolators shall be Type D spring hangers.

- I. Vibration isolators shall be as follows:
 - 1. Type B Spring Mounting: Spring type isolators shall be free standing and laterally stable without any housing and complete with 1/4" neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflections, compressed spring height and solid spring height. Mountings shall be type SLF as manufactured by Mason Industries, Inc. or equal by Amber-Booth.
 - 2. Type C Spring Mounting: Equipment with operating weight different from the installed weight, such as chillers, boilers, etc. and equipment exposed to the wind, such as cooling towers, shall be mounted on spring mountings Type B, but a housing shall be used that includes vertical limit stops to prevent spring extension when weight is removed. Restrained mountings shall include springs that are free standing and laterally stable and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the spring and the mounting baseplate. All spring assemblies shall have leveling bolts. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mount housing shall include vertical limit stops to prevent spring extension when weight is removed. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical and horizontal directions. A minimum clearance of 3/8:" shall be maintained around restraining bolts so as not to interfere with the spring action. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type SLR as manufactured by Mason Industries, Inc.
 - 3. Type D Spring Hangers: Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be type 30N as manufactured by Mason Industries, Inc. or equal by Amber-Booth.
 - 4. Type P Neoprene Pad: A pad type mounting consisting of two layers of 3/8" thick ribbed or waffled bridge bearing neoprene pads bonded to a 16 gage galvanized steel separator plate. Anchor bolt with neoprene washer and sleeve.
- J. Seismic Restraints:
 - 1. General: The intent of the seismic restraints is to restrain the mechanical equipment, pipes and ducts during an earthquake for life safety purposes;

to prevent equipment from overturning; to prevent suspended equipment, pipes and ducts from swaying or falling and creating a potential life safety hazard. For "Essential" and "Hazardous" facilities (as defined in the Uniform Building Code), the intent of the seismic restraint system also includes keeping the mechanical systems operational during and following an earthquake. See Section 05500 "Metal Fabrication" for standards for miscellaneous metal fabrication.

2. The following mechanical items shall be seismically braced as specified, detailed on the drawings, recommended by SMACNA, or as recommended by the Seismic and Vibration Control manufacturer:
 - a. Base Mounted Pumps - anchor bolts
 - b. Chiller
 - c. Fancoil Units
 - d. Exhaust Fans
 - e. All duct work and piping shall be provided with seismic restraints in accordance with the 2003 International Building Code.
3. Connections of the seismic bracing to the structure shall be coordinated with the General Contractor and acceptable to the Structural Engineers. In general, connect to beams, concrete slabs, or to the top member of the joists at the panel points. Division 15 shall provide spanner beams where required for seismic bracing. Seismic anchorage shall extend through concrete house keeping pads and anchor to the building floor slabs.
4. The Seismic and Vibration Control manufacturer shall determine the number, size, and type of anchor bolts, cable restraints, seismic snubbers, etc., for each piece of equipment and groups of pipes and ducts. Individual pipes and ducts shall be braced as per the Mason Industries Seismic Restraint Guidelines for IBC 2003 details and approved and verified by the Seismic and Vibration Control manufacturer.

K. Seismic Snubbers:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certifies direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. The snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than 1/4". Snubbers shall be installed with factory set clearances.
2. The capacity of the seismic snubber at 3/8" deflection shall be 3 to 4 times the load assigned to the mount grouping in its immediate area. Submittals shall include load deflection curves up to 1/2" deflection in the y and z planes. Test shall be conducted in an independent laboratory or under the signed supervision of an independent registered engineer. The snubber assemblies shall be bolted to the test machine as the snubber is

normally installed. Test reports shall certify that neither the neoprene elements nor the snubber body sustained any obvious deformation after release of load. Snubbers shall be series Z-1011 as manufactured by Mason Industries, Inc. or equal by Amber-Booth.

END OF SECTION 15071

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes mechanical identification materials and devices.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for identification materials and devices.
- C. Samples of color, lettering style, and other graphic representation required for each identification material and device.

1.4 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate installation of identifying devices after completion of covering and painting where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS

- A. General: Products specified are manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. Where more than single type is specified for listed application, selection is Installer's option, but provide single selection for each product category.

- B. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ASME A13.1. Minimum letter height is 1-1/4 (30 mm) inches for ducts and 3/4 (19 mm) inch for access door signs and similar operational instructions.
 - 1. Material: Fiberboard or brass.
 - 2. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ASME A13.1, except as otherwise indicated.
- C. Pressure-Sensitive Pipe Markers: Manufacturer's standard pre-printed, color-coded, pressure-sensitive vinyl pipe markers, with permanent adhesive conforming to ASME A13.1.
- D. Pipes Smaller Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
- E. Pipes 6 Inches (150 mm) And Larger: Either full-band or strip-type pipe markers, at least 3 times the letter height and of length required for label.
- F. Lettering: Manufacturer's standard pre-printed terms as selected by Architect.
- G. Lettering: Use piping system terms as indicated and abbreviate only as necessary for each application length.
 - 1. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.
- H. Plastic Duct Markers: Manufacturer's standard laminated plastic, duct markers in the following color code:
 - 1. Green: Cold air.
 - 2. Yellow: Hot air.
 - 3. Yellow/Green: Supply air.
 - 4. Blue: Exhaust, outside, return, and mixed air.
 - 5. For hazardous materials exhausts, use colors and designs recommended by ASME A13.1.
 - 6. Terminology: Include direction of air flow, duct service (supply, return, exhaust, etc.), duct origin (from), duct destination (to), and design cfm.
- I. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3-mils thick.
 - 1. Width: 1-1/2-inches (38 mm) wide on pipes with outside diameters (including insulation) less than 6 inches (150 mm); 2-1/2-inches (65 mm) wide for larger pipes.
 - 2. Color: Comply with ASME A13.1, except where another color selection is indicated.

- J. Valve Tags: Stamped or engraved with 1/4-inch (6 mm) letters for piping system abbreviation and 1/2-inch (13 mm) sequenced numbers. Provide a 5/32-inch (4 mm) hole for fastener.
 - 1. Material: 19-gage polished brass.
 - 2. Size: 1-1/2-inches (38 mm) diameter, except as otherwise indicated.
- K. Valve Tag Fasteners: Brass chain (wire link or beaded type) or brass S-hooks.
- L. Access Panel Markers: 1/16-inch-thick (1.5 mm) engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch (3 mm) center hole for attachment.
- M. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Engraved with engraver's standard letter style, of sizes and with terms to match equipment identification.
 - 2. Thickness: 1/16 inch (1.5 mm), for units up to 20 square inches (13,000 sq. mm) or 8 inches (200 mm) length; 1/8 inch (3 mm) for larger units.
 - 3. Fasteners: Self-tapping stainless steel screws or contact-type permanent adhesive.
- N. Plastic Equipment Markers: Laminated-plastic, in the following color code:
 - 1. Green: Cooling equipment and components.
 - 2. Yellow: Heating equipment and components.
 - 3. Yellow/Green: Combination cooling and heating equipment and components.
 - 4. Brown: Energy reclamation equipment and components.
 - 5. Blue: Equipment and components that do not meet any of above criteria.
 - 6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
 - 7. Terminology: Include following, matching schedules as closely as possible:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.
 - 8. Size: Approximate 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; and 4-1/2 by 6 inches (115 by 150 mm) for equipment.
- O. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service (such as Boiler No. 3, Air Supply No. 1H, or Standpipe F12).

PART 3 - EXECUTION

3.1 LABELING AND IDENTIFYING

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
 1. Stenciled Markers: Complying with ASME A13.1.
 2. Plastic markers, with application systems. Install on pipe insulation segment where required for hot non-insulated pipes.
 - a. Fasten markers on pipes 6 inches (150 mm) and larger by one of following methods:
 - 1) Laminated or bonded application of pipe marker to pipe (or insulation).
 - 2) Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2-inches (38 mm) wide, lapped 3 inches (75 mm) minimum at both ends of pipe marker, and covering full circumference of pipe.
 3. Locate pipe markers and color bands as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - a. Near each valve and control device.
 - b. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
 - c. Near penetrations through walls, floors, ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes, and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced at a maximum of 50-feet (15 m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.
 - g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- B. Valve Tags: Install valve tag on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, shut-off valves, faucets, convenience and lawn-watering hose bibbs, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in valve schedule.
 1. Install mounted valve schedule in each major equipment room.

- C. Equipment: Install engraved plastic laminate signs or equipment markers on or near each major item of mechanical equipment. Provide signs for following general categories of equipment:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gages, thermometers, and similar units.
 - 3. Fuel-burning units including unit heaters.
 - 4. Pumps, chillers, and similar motor- driven units.
 - 5. Packaged HVAC central-station and zone-type units.
 - 6. Tanks and pressure vessels.
 - 7. Strainers, filters, humidifiers, water treatment systems, and similar equipment.

3.2 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices which have become visually blocked by work of this Division or other Divisions.
- B. Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 15075

SECTION 15080 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe insulation.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 15 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 DEFINITIONS

- A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.
- B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.
- C. Cold Surfaces: Normal operating temperatures less than 75 deg F.
- D. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.
- E. Density: Is expressed in lb/sq.ft.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.
- C. Material test reports prepared by a qualified independent testing laboratory. Certify insulation meets specified requirements.

1.5 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
 - 1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
 - 2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.6 SEQUENCING AND SCHEDULING

- A. Schedule insulation application after testing of piping and duct systems.
- B. Schedule insulation application after installation and testing of heat trace tape.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Glass Fiber:
 - a. CertainTeed Corporation.
 - b. Knauf Fiberglass GmbH.
 - c. Manson.
 - d. Owens-Corning Fiberglas Corporation.
 - e. John Manville.
 - f. USG Interiors, Inc. - Thermafiber Division.

2.2 GLASS FIBER

- A. Material: Inorganic glass fibers, bonded with a thermosetting resin.
- B. Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.
- C. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, jacketed.
 - 1. Thermal Conductivity: 0.25 average maximum at 75 deg F mean temperature.
 - 2. Density: 10 pcf average maximum.
- D. Adhesive: Produced under the UL Classification and Follow-up service.
 - 1. Type: Non-flammable, solvent-based.
 - 2. Service Temperature Range: Minus 20 to 180 deg F.

- E. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.3 CALCIUM SILICATE (AT HANGERS)

- A. Material: ASTM C 533, Type I; inorganic, hydrous calcium silicate, non-asbestos fibrous reinforcement; incombustible.
- B. Form: Molded flat block, curved block, grooved block, and preformed pipe sections as appropriate for surface.
- C. Thermal Conductivity: 0.60 at 500 deg F.
- D. Dry Density: 15.0 pcf maximum.
- E. Compressive Strength: 60 psi minimum at 5 percent deformation.
- F. Fire Performance Characteristics: Provide materials identical to those whose fire performance characteristics have been determined, per test method indicated below, by UL or other testing and inspecting organization acceptable to authorities having jurisdiction.
 - 1. Test Method: ASTM E 84.
 - 2. Flame Spread: 0.
 - 3. Smoke Developed: 0.

2.4 INSULATING CEMENTS

- A. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: ASTM C 449.
 - 1. Thermal Conductivity: 1.2 average maximum at 400 deg F mean temperature.
 - 2. Compressive Strength: 100 psi at 5 percent deformation.

2.5 ADHESIVES

- A. Lagging Adhesive: MIL-A-3316C, non-flammable adhesive in the following Classes and Grades:
 - 1. Class 1, Grade A for bonding glass cloth and tape to unfaced glass fiber insulation, sealing edges of glass fiber insulation, and bonding lagging cloth to unfaced glass fiber insulation.
 - 2. Class 2, Grade A for bonding glass fiber insulation to metal surfaces.

2.6 JACKETS

- A. General: ASTM C 921, Type 1, except as otherwise indicated.
- B. PVC Jacketing: High-impact, ultra-violet-resistant PVC, 20-mils thick, roll stock ready for shop or field cutting and forming to indicated sizes.
 - 1. Adhesive: As recommended by insulation manufacturer.

2. Color:
 - a. White in all areas except tunnels and equipment rooms.
 - b. In Equipment Rooms, color matching background identification color as specified in Section 15075 (ASME 13).
- C. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultra-violet-resistant PVC.
 1. Adhesive: As recommended by insulation manufacturer.
 2. Color:
 - a. White in all areas except tunnels and equipment rooms.
 - b. In Equipment Rooms, color matching background identification color as specified in Section 15075 (ASME 13).

2.7 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, presized a minimum of 8 ounces per sq. yd.
 1. Tape Width: 4 inches.
 2. Cloth Standard: MIL-C-20079H, Type I.
 3. Tape Standard: MIL-C-20079H, Type II.
- B. Bands: 3/4-inch wide, in one of the following materials compatible with jacket:
 1. Stainless Steel: Type 304, 0.020 inch thick.
 2. Galvanized Steel: 0.005 inch thick.
 3. Aluminum: 0.007 inch thick.
 4. Brass: 0.01 inch thick.
 5. Nickel-Copper Alloy: 0.005 inch thick.
- C. Wire: 14-gage nickel copper alloy, 16-gage, soft-annealed stainless steel, or 16-gage, soft-annealed galvanized steel.
- D. Corner Angles: 28-gage, 1-inch by 1-inch aluminum, adhered to 2-inch by 2-inch kraft paper.
- E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

2.8 SEALING COMPOUNDS

- A. Vapor Barrier Compound: Water-based, fire-resistive composition.
 1. Water Vapor Permeance: 0.08 perm maximum.
 2. Temperature Range: Minus 20 to 180 deg F.
- B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.
 1. Water Vapor Permeance: 0.02 perm maximum.

2. Temperature Range: Minus 50 to 250 deg F.
3. Color: Aluminum.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.
- B. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.
 1. Follow cement manufacturer's printed instructions for mixing and portions.

3.2 INSTALLATION, GENERAL

- A. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.
- B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.
- C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 deg F.
- D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.
- E. Install insulation with smooth, straight, and even surfaces.
- F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.
- G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.
- H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.
- I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.
- J. Keep insulation materials dry during application and finishing.

- K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:
1. Fibrous glass ducts.
 2. Metal ducts with duct liner located inside building insulation envelope.
 3. Factory-insulated flexible ducts.
 4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 5. Flexible connectors for ducts and pipes.
 6. Vibration control devices.
 7. Testing laboratory labels and stamps.
 8. Nameplates and data plates.
 9. Access panels and doors in air distribution systems.
 10. Fire protection piping systems.
 11. Sanitary drainage and vent piping, unless indicated otherwise.
 12. Drainage piping located in crawl spaces, unless indicated otherwise.
 13. Below grade buried piping.
 14. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
 15. Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.
 16. Factory insulated equipment.

3.3 PIPE INSULATION INSTALLATION, GENERAL

- A. Tightly butt longitudinal seams and end joints. Bond with adhesive.
- B. Stagger joints on double layers of insulation.
- C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.
- D. Apply insulation with a minimum number of joints.
- E. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
 2. Cover circumferential joints with butt strips, at least 3-inches wide, and of same material as insulation jacket. Secure with adhesive and outward clinching staples along both edges of butt strip and space 4 inches on center.
 3. Longitudinal Seams: Overlap seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
 - a. Exception: Do not staple longitudinal laps on insulation applied to piping systems with surface temperatures at or below 35 deg F.
 4. Vapor Barrier Coatings: Where vapor barriers are indicated, apply on seams and joints, over staples, and at ends butt to flanges, unions, valves, and fittings.

5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.
 6. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere, staple, and seal. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.
- F. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.
- G. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 2 inches from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer. Refer to Division 7 Section "Joint Sealants."
- H. Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with firestopping or fire-resistant joint sealer. Refer to Division 7 for firestopping and fire-resistant joint sealers.
- I. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.
- J. Flanges, Fittings, Valves, and Roof Drain Bowls - Interior Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, fittings, and roof drain bowls. Make joints tight. Bond with adhesive.
1. Use same material and thickness as adjacent pipe insulation.
 2. Overlap nesting insulation by 2 inches or 1-pipe diameter, whichever is greater.
 3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.
 4. Insulate elbows and tees smaller than 3-inches pipe size with premolded insulation.
 5. Insulate elbows and tees 3 inches and larger with premolded insulation or insulation material segments. Use at least 3 segments for each elbow.
 6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.
- K. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields, and inserts as specified in Division 15 Section "Hangers and Supports." For cold surface piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.

1. Inserts and Shields: Cover hanger inserts and shields with jacket material matching adjacent pipe insulation.

3.4 GLASS FIBER PIPE INSULATION INSTALLATION

- A. Bond insulation to pipe with lagging adhesive.
- B. Seal exposed ends with lagging adhesive.
- C. Seal seams and joints with vapor barrier compound.

3.5 FINISHES

- A. Paint finished insulation (except colored PVC jacket) as specified in Division 9 Section "Painting."

3.6 APPLICATIONS

- A. General: Materials and thicknesses are specified in schedules at the end of this Section.
- B. Interior Piping Systems: Unless otherwise indicated, insulate the following piping systems:
 1. Chilled water (40 to 55°F.)

3.7 PIPE INSULATION SCHEDULES

- A. General: Abbreviations used in the following schedules include:
 1. Field-Applied Jackets: P - PVC.
 2. Pipe Sizes: NPS - Nominal Pipe Size.
 3. All system piping shall be thermally insulated in accordance with ASHRAE 90.1-89, table 403.2.9.1.

INTERIOR CHILLED WATER
(40 TO 60 DEG. F)

PIPE SIZES (NPS)	MATERIALS	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
<1	GLASS FIBER	1	YES	CONCEALED (NONE) EXPOSED (P)
1 TO <1-1/2	GLASS FIBER	1	YES	CONCEALED (NONE) EXPOSED (P)
1-1/2 TO <4	GLASS FIBER	1-1/2"	YES	CONCEALED (NONE) EXPOSED (P)
4 TO <8	GLASS FIBER	2"	YES	CONCEALED (NONE) EXPOSED (P)
≥ 8	GLASS FIBER	2"	YES	CONCEALED (NONE) EXPOSED (P)

END OF SECTION 15080

SECTION 15110 - VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general duty valves common to several mechanical piping systems.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Special purpose valves are specified in Division 15 piping system Sections.
 - 2. Valve tags and charts are specified in Division 15 Section "Mechanical Identification."

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.
- C. Maintenance data for valves to include in the operation and maintenance manual. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section "Materials and Equipment," under "Source Limitations" Paragraph.
- B. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set globe and gate valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Gate Valves:
 - a. Crane Company; Valves and Fitting Division.
 - b. Hammond Valve Corporation.
 - c. Jenkins Valve.
 - d. Kitz Corp. of America.
 - e. Lunkenheimer/Cincinnati Valve Co.
 - f. Milwaukee Valve Company, Inc.
 - g. NIBCO Inc.
 - h. Powell: Wm. Powell Company (The).
 - i. Red-White Valve Corp.
 - j. Stockham Valves & Fittings, Inc.
 - k. Watts Industries, Inc.

2. Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Division.
 - b. Crane Company; Valves and Fitting Division.
 - c. Hammond Valve Corporation.
 - d. Jamesbury.
 - e. Jenkins Valve.
 - f. Lunkenheimer/Cincinnati Valve Co.
 - g. Milwaukee Valve Company, Inc.
 - h. NIBCO Inc.
 - i. Powell: Wm. Powell Company (The).
 - j. Stockham Valves & Fittings, Inc.
 - k. Tyco, Keystone.
 - l. Tyler Pipe.
 - m. Victaulic Company of America.
 - n. Watts Industries, Inc.
3. Plug Valves:
 - a. Grinnell Corp.
 - b. Homestead Valve Co.
 - c. Huber: J.M. Huber Corp.; Flow Control Division (Resun Valves).
 - d. Lunkenheimer/Cincinnati Valve Co.
 - e. NIBCO Inc.
 - f. Powell: Wm. Powell Company (The).
 - g. Stockham Valves & Fittings, Inc.
 - h. Victaulic Company of America.
4. Globe Valves:
 - a. Crane Company; Valves and Fitting Division.
 - b. Hammond Valve Corporation.
 - c. Jenkins Valve.
 - d. Kitz Corp. of America.
 - e. Lunkenheimer/Cincinnati Valve Co.
 - f. Milwaukee Valve Company, Inc.
 - g. NIBCO Inc.
 - h. Powell: Wm. Powell Company (The).
 - i. Red-White Valve Corp.
 - j. Stockham Valves & Fittings, Inc.
 - k. Watts Industries, Inc.
5. Butterfly Valves:
 - a. Bray Valve and Controls.
 - b. Center Line, Mark Controls Corporation.
 - c. Crane Company; Valves and Fitting Division.
 - d. General Signal; DeZurik Unit.
 - e. Grinnell Corp.
 - f. Hammond Valve Corporation.
 - g. Milwaukee Valve Company, Inc.
 - h. NIBCO Inc.

- i. Powell: Wm. Powell Company (The).
 - j. Red-White Valve Corp.
 - k. Stockham Valves & Fittings, Inc.
 - l. Tyco, Keystone.
 - m. Tyler Pipe.
 - n. Ultraflo Corporation.
 - o. Victaulic Company of America.
 - p. Watts Industries, Inc.
6. Swing Check Valves:
- a. Cla-Val Co.
 - b. Crane Company; Valves and Fitting Division.
 - c. Hammond Valve Corporation.
 - d. Jenkins Valve.
 - e. Kitz Corp. of America.
 - f. Lunkenheimer/Cincinnati Valve Co.
 - g. Milwaukee Valve Company, Inc.
 - h. NIBCO Inc.
 - i. Powell: Wm. Powell Company (The).
 - j. Red-White Valve Corp.
 - k. Stockham Valves & Fittings, Inc.
 - l. Tyco, Prince.
 - m. Victaulic Company of America.
 - n. Watts Industries, Inc.
7. Wafer Check Valves:
- a. Cla-Val Co.
 - b. Center Line, Mark Controls Corp.
 - c. Conbraco Industries, Inc.; Apollo Division.
 - d. Hammond Valve Corporation.
 - e. Kitz Corp. of America.
 - f. Metraflex Company.
 - g. Milwaukee Valve Company, Inc.
 - h. NIBCO Inc.
 - i. Red-White Valve Corp.
 - j. Stockham Valves & Fittings, Inc.
 - k. Tyco, Prince.
 - l. Tyler Pipe.
 - m. Val-Matic Valve & Mfg. Corp.
 - n. Victaulic Company of America.
 - o. Watts Industries, Inc.
8. Lift Check Valves:
- a. Crane Company; Valves and Fitting Division.
 - b. Hammond Valve Corporation.
 - c. Jenkins Valve.
 - d. Kitz Corp. of America.
 - e. Lunkenheimer/Cincinnati Valve Co.

- f. Milwaukee Valve Company, Inc.
- g. NIBCO Inc.
- h. Powell: Wm. Powell Company (The).
- i. Red-White Valve Corp.
- j. Stockham Valves & Fittings, Inc.
- k. Watts Industries, Inc.

2.2 BASIC, COMMON FEATURES

- A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.
 - 1. Nonrising stem valves may be used only where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.
- C. Sizes: Same size as upstream pipe, unless otherwise indicated.
- D. Operators: Use specified operators and handwheels, except provide the following special operator features:
 - 1. Handwheels: For valves other than quarter turn.
 - 2. Lever Handles: For quarter-turn valves 6 inches (DN150) and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
 - 3. Chain-Wheel Operators: For valves 4 inches (DN100) and larger, installed 72 inches (2400 mm) or higher above finished floor elevation.
 - 4. Gear-Drive Operators: For quarter-turn valves 8 inches (DN200) and larger.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.
- G. Threads: ASME B1.20.1.
- H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

2.3 GATE VALVES

- A. Gate Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi (1380-kPa) cold working pressure (CWP), or Class 150, 300-psi (2070-kPa) CWP; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, copper-

silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

- B. Gate Valves, 3 Inches (DN80) and Larger: MSS SP-70, Class 125, 200-psi (1380-kPa) CWP, ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron handwheel.

2.4 BALL VALVES

- A. Ball Valves, 4 Inches (DN100) and Smaller: MSS SP-110, Class 150, 600-psi (4140-kPa) CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch (DN15) valves and smaller and conventional port for 3/4-inch (DN20) valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:
 - 1. Operator: Vinyl-covered steel lever handle.
 - 2. Operator: Lever operators with lock where used for throttling duty.
 - 3. Stem Extension: For valves installed in insulated piping.
 - 4. Memory Stop: For operator handles where used for throttling duty.

2.5 PLUG VALVES

- A. Plug Valves: MSS SP-78, 175-psi (1200-kPa) CWP, ASTM A 126 cast-iron body and bonnet, cast-iron plug, Buna N, Viton, or teflon packing, flanged or grooved end connections:
 - 1. Operator: Lever or square head with 1 wrench for every 10 valves.
 - 2. Operator: Worm and gear with handwheel, sizes 6 inches (DN150) and larger.
 - 3. Operator: Worm and gear with chain wheel, sizes 6 inches (DN150) and larger, 96 inches (2400 mm) or higher above floor.

2.6 GLOBE VALVES

- A. Globe Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi (1380-kPa) CWP, or Class 150, 300-psi (2070-kPa) CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.
- B. Globe Valves, 3 Inches (DN80) and Larger: MSS SP-85, Class 125, 200-psi (1380-kPa) CWP, ASTM A 126 cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.7 BUTTERFLY VALVES

- A. Butterfly Valves: MSS SP-67, 200-psi (1380-kPa) CWP, 150-psi (1035- kPa) maximum pressure differential, ASTM A 126 cast-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals, lug, or grooved style:
 - 1. Disc type as indicated in application schedule:
 - a. Nickel-plated ductile iron.
 - b. Aluminum bronze.
 - c. Elastomer-coated ductile iron.
 - d. Epoxy-coated ductile iron.
 - 2. Operator for Sizes 2 Inches (DN50) to 6 Inches (DN150): Standard lever handle with memory stop.
 - 3. Operator for Sizes 8 Inches (DN200) to 24 Inches (DN600): Gear operator with position indicator.
 - 4. Operator for Sizes 8 Inches (DN200) and Larger, 96 Inches (2400 mm) or Higher above Floor: Chain-wheel operator.

2.8 CHECK VALVES

- A. Swing Check Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi (1380-kPa) CWP, or Class 150, 300-psi (2070-kPa) CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections.
- B. Swing Check Valves, 3 Inches (DN80) and Larger: MSS SP-71, Class 125, 200-psi (1380-kPa) CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.
- C. Wafer Check Valves: Class 125, 200-psi (1380-kPa) CWP, ASTM A 126 cast-iron body, bronze disc/plates, stainless-steel pins and springs, Buna N seals, installed between flanges.
- D. Lift Check Valves: Class 125, ASTM B 62 bronze body and cap (main components), horizontal or vertical pattern, lift-type, bronze disc or Buna N rubber disc with stainless-steel holder threaded or soldered end connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. For chain-wheel operators, extend chains to 60 inches (1500 mm) above finished floor elevation.
- H. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
 - 2. Wafer Check Valves: Horizontal or vertical position, between flanges.
 - 3. Lift Check Valve: With stem upright and plumb.

3.3 THREADED CONNECTIONS

- A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.

- C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.4 FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.5 VALVE END SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Steel Pipe Sizes, 2-1/2 Inches (DN65) and Smaller: Threaded or grooved end.
 - 2. Steel Pipe Sizes, 3 Inches (DN80) and Larger: Grooved end or flanged.

3.6 APPLICATION SCHEDULE

- A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
 - 1. Gate Valves: Class 125, bronze or cast-iron body to suit piping system.
 - 2. Ball Valves: Class 150, 600-psi (4140-kPa) CWP, with stem extension.
 - 3. Plug Valves: Neoprene-faced plug, Buna N packing.
 - 4. Globe Valves: Class 125, bronze or cast-iron body to suit piping system, and bronze or teflon disc.
 - 5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
 - 6. Bronze Swing Check: Class 125, with rubber seat.
 - 7. Check Valves: Class 125, swing or wafer type as indicated.
- C. Chilled-Water Systems: Use the following valve types:
 - 1. Gate Valves: Class 150, bronze body; or Class 125, cast-iron body.
 - 2. Ball Valves: Class 150, 600-psi (4140-kPa) CWP, with stem extension and memory stop.
 - 3. Plug Valves: Buna N packing.

4. Globe Valves: Class 125, bronze body with bronze or teflon disc; or Class 125, cast-iron body.
 5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM sleeve and stem seals.
 6. Check Valves: Class 125, bronze body swing check with rubber seat; Class 125, cast-iron body swing check; Class 125, cast-iron body wafer check; or Class 125, cast-iron body lift check.
- D. Condenser Water Systems: Use the following valve types:
1. Gate Valves: Class 125, bronze body; or Class 125, cast-iron body.
 2. Ball Valves: Class 150, 600-psi (4140-kPa) CWP, with memory stop.
 3. Plug Valves: Buna N packing.
 4. Globe Valves: Class 125, bronze body with bronze or teflon disc; or Class 125, cast-iron body.
 5. Butterfly Valves: Aluminum bronze, epoxy-coated ductile iron disc; EPDM sleeve and stem seals.
 6. Check Valves: Class 125, bronze body swing check with rubber seat; Class 125, cast-iron body swing check; Class 125, cast-iron body wafer check; or Class 125, cast-iron body lift check.

3.7 ADJUSTING

- A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 15110

SECTION 15122 - METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes meters and gages used in mechanical systems.
- B. Related Sections: Division 15 piping Sections contain requirements that relate to this Section.
 - 1. Meters and gages furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 15 Sections.

1.3 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.
- C. Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.
- D. Maintenance data to include in the "Operating and Maintenance Manuals". Include data for the following:
 - 1. Test plugs.
 - 2. Flow measuring systems.
 - 3. Flow meters.
 - 4. Btu meters.

1.4 QUALITY ASSURANCE

- A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

- B. Design Criteria: The Drawings indicate types, sizes, capacities, ranges, profiles, connections, and dimensional requirements of meters and gages and are based on the specific manufacturer types and models indicated. Meters and gages having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of meters and gages is on the proposer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Liquid-in-Glass Thermometers:
 - a. Marsh Instrument Co.
 - b. Marshalltown Instruments, Inc.
 - c. H.O. Trerice Co.
 - d. Weiss Instruments, Inc.
 - e. Weksler Instruments Corp.
 2. Insertion Dial Thermometers:
 - a. Ashcroft by Dresser Industries, Instrument Div.
 - b. Reotemp Instrument Corp.
 - c. Tel-Tru Manufacturing Co., Inc.
 - d. H.O. Trerice Co.
 - e. Weiss Instruments, Inc.
 - f. Weksler Instruments Corp.
 3. Pressure Gages:
 - a. AMETEK, U.S. Gauge Div.
 - b. Ashcroft by Dresser Industries, Instrument Div.
 - c. Marsh Instrument Co.
 - d. Marshalltown Instruments, Inc.
 - e. H.O. Trerice Co.
 - f. Weiss Instruments, Inc.
 - g. Weksler Instruments Corp.
 - h. WIKA Instruments Corp.
 4. Test Plugs:
 - a. Flow Design, Inc.
 - b. MG Piping Products Co.
 - c. Peterson Equipment Co., Inc.
 - d. Sisco Co., Spedco, Inc.
 - e. H.O. Trerice Co.
 - f. Watts Regulator Co.

- 5. Venturi-Type Flow Elements:
 - a. Armstrong Pumps, Inc.
 - b. BIF by Leeds & Northrup.
 - c. Badger Meter, Inc.
 - d. Barco Div., Marison Industries.
 - e. Fischer & Porter Co.
 - f. Gerand Engineering Co.
 - g. Preso Industries, Ltd.
 - h. Victaulic Company of America.

2.2 THERMOMETERS, GENERAL

- A. Scale Range: Temperature ranges for services listed as follows:
 - 1. Condenser Water: 0 to 100 deg F, with 2-degree scale divisions (minus 18 to 70 deg C, with 1-degree scale divisions).
 - 2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions (minus 18 to 38 deg C, with 1-degree scale divisions).
- B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Description: ASTM E 1, liquid-in-glass thermometer.
- B. Case: Die-cast and aluminum-finished in baked-epoxy enamel, glass front, spring secured, 9 inches (230 mm) long.
- C. Adjustable Joint: Finished to match case, 180-degree (3.1rad) adjustment in vertical plane, 360-degree (6.3rad) adjustment in horizontal plane, with locking device.
- D. Tube: Red-reading mercury-filled with magnifying lens.
- E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.
- F. Stem: Copper-plated, steel, aluminum, or brass for a separable socket of length to suit installation.

2.4 REMOTE-READING, FILLED-SYSTEM DIAL THERMOMETERS

- A. Description: Vapor-actuated remote-reading dial thermometer.
- B. Case: Drawn steel or cast aluminum, with 4-1/2-inch (115mm) -diameter glass lens.
- C. Movement: Brass, precision geared.

- D. Scale: Progressive satin-faced nonreflective aluminum with permanently etched markings.
- E. Tubing: Bronze double-braided armor-over-copper capillary of length to suit installation.
- F. Bulb: Copper with separable socket for liquids; averaging element for air.

2.5 THERMOMETER WELLS

- A. Description: Brass or stainless-steel thermometer well.
- B. Pressure Rating: Not less than piping system design pressure.
- C. Stem Length: To extend 2 inches (50 mm) into fluid.
- D. Extension for Insulated Piping: 2 inches (50 mm) nominal, but not less than thickness of insulation.
- E. Threaded Cap Nut: With chain permanently fastened to well and cap.

2.6 PRESSURE GAGES

- A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon- tube pressure gage, bottom connection, liquid filled.
- B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch (115mm) -diameter glass lens.
- C. Connector: Brass, 1/4-inch (8mm) NPS.
- D. Scale: White-coated aluminum, with permanently etched markings.
- E. Accuracy: Plus or minus 1 percent of range span.
- F. Range: Conform to the following:
 - 1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.
 - 2. Vacuum: 100 kPa of vacuum to 100 kPa of pressure.
 - 3. Fluids Under Pressure: 0 to 150 psig of pressure.

2.7 PRESSURE-GAGE ACCESSORIES

- A. Snubbers: 1/4-inch (8mm) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

- A. Description: Nickel-plated brass-body test plug in 1/2-inch (15mm) fitting.

- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: 500 psig (3450 kPa) minimum.
- D. Core Inserts: 2 self-sealing valve types, suitable for inserting a 1/8-inch (3mm) outside-diameter probe from a dial thermometer or pressure gage.
- E. Core Material: According to the following for fluid and temperature range:
 - 1. Air, Water, Oil, and Gas: 20 to 200 deg F (minus 7 to 93 deg C), neoprene rubber.
 - 2. Air and Water: Minus 30 deg to 275 deg F (minus 35 to 136 deg C), ethylene-propylene-diene-terpolymer (EPDM) rubber.
- F. Test-Plug Cap: Gasketed and threaded cap, with retention chain.
- G. Test Kit: Provide test kit consisting of 1 pressure gage and gage adapter with probe, 2 bimetal dial thermometers and a carrying case.
- H. Pressure Gage and Thermometer Ranges: Approximately 2 times systems operating conditions.

2.9 VENTURI FLOW ELEMENTS

- A. Description: Venturi differential-pressure-design flow-element fitting made for installation in piping.
- B. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data. Include ends threaded for 2-inch (50mm) and smaller elements and flanged or welded for 2-1/2-inch (65mm) and larger elements.
- C. Pressure Rating: 250 psig (1725 kPa).
- D. Temperature Rating: 250 deg F (120 deg C).

PART 3 - EXECUTION

3.1 METER AND GAGE APPLICATIONS

- A. General: Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

3.2 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.

3.3 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install in the following locations and elsewhere as indicated:
 - 1. At inlet and outlet of each hydronic chiller.
 - 2. At inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
- C. Remote-Reading Dial Thermometers: Install in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- D. Thermometer Wells: Install in vertical position in piping tees where thermometers are indicated.
 - 1. Install wells with stem extending minimum of 2 inches (50 mm) into fluid.
 - 2. Fill wells with oil or graphite and secure caps.

3.4 PRESSURE GAGE INSTALLATION

- A. Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position.
- B. Install in the following locations and elsewhere as indicated:
 - 1. At suction and discharge of each pump.
 - 2. At chilled water and condenser water inlets and outlets of chillers.
- C. Pressure Gage Valves: Install ballvalve for water, needle valve for steam, in piping tee with snubber. Install syphon instead of snubber for steam pressure gages.

3.5 TEST PLUG INSTALLATION

- A. Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

3.6 FLOW-MEASURING SYSTEM, FLOW ELEMENT AND METER INSTALLATION

- A. General: Install flow meters for piping systems located in accessible locations at most readable position.
- B. Locations: Install flow measuring elements as indicated.
- C. Install connection fittings for attachment to portable flow meters in readily accessible locations.

3.7 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.
- C. Cleaning: Clean windows of gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 15122

SECTION 15150 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Sections include the following:
 - 1. Division 15 Section "Chemical-Waste Piping" for chemical-waste and vent piping systems.
 - 2. Division 15 Section "Sewage Pumps."

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

- a. Available Manufacturers:
 - 1) ANACO.
 - 2) Fernco, Inc.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.
- 2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) ANACO.
 - 2) Clamp-All Corp.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.
- 3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) MG Piping Products Co.
- C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. ANACO.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping **NPS 4 (DN 100)** and smaller shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
 - 2. Hubless cast-iron soil pipe and fittings; standard, couplings; and hubless-coupling joints.
- C. Aboveground, vent piping **NPS 4 (DN 100)** and smaller shall be the following:
 - 1. Hubless cast-iron soil pipe and fittings; standard, couplings; and hubless-coupling joints.

- D. Underground, soil, waste, and vent piping **NPS 4 (DN 100)** and smaller shall be the following:
 - 1. Extra-Heavy, Service class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; standard and cast-iron couplings; and hubless-coupling joints.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 2 Section "Sanitary Sewerage."
- B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."
- D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping **NPS 3 (DN 80)** and smaller; 1 percent downward in direction of flow for piping **NPS 4 (DN 100)** and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- D. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 15 Section "Valves."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."
- B. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. **100 Feet (30 m)** and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than **100 Feet (30 m)**: MSS Type 43, adjustable roller hangers.

- c. Longer Than **100 Feet (30 m)**, if Indicated: MSS Type 49, spring cushion rolls.
- 3. Multiple, Straight, Horizontal Piping Runs **100 Feet (30 m)** or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 15 Section "Hangers and Supports."
- D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm)** with **3/8-inch (10-mm)** rod.
 - 2. **NPS 3 (DN 80): 60 inches (1500 mm)** with **1/2-inch (13-mm)** rod.
 - 3. **NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm)** with **5/8-inch (16-mm)** rod.
 - 4. **NPS 6 (DN 150): 60 inches (1500 mm)** with **3/4-inch (19-mm)** rod.
 - 5. **NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm)** with **7/8-inch (22-mm)** rod.
- E. Install supports for vertical cast-iron soil piping every **15 feet (4.5 m)**.
- F. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than **10-foot head of water (30 kPa)**. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1-inch wg (250 Pa)**. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150

SECTION 15181 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.
- B. The following Division-15 Sections apply to this Section:
 - 1. Basic Mechanical Requirements.
 - 2. Basic Mechanical Materials and Methods.
 - 3. Valves.
 - 4. Hangers and Supports.

1.2 SUMMARY

- A. This Section includes piping systems for chilled water, condenser water, and condensate drain piping. Piping materials and equipment specified in this Section include:
 - 1. Pipes, fittings, and specialties;
 - 2. Special duty valves;
 - 3. Hydronic specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Earthwork" for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 7 Section "Joint Sealant" for materials and methods for sealing pipe penetrations through basement walls, and fire and smoke barriers.
 - 3. Division 15 Section "Valves" for gate, globe, ball, butterfly, and check valves.
 - 4. Division 15 Section "Meters and Gages" for thermometers, flow meters, and pressure gages.
 - 5. Division 15 Section "Mechanical Identification" for labeling and identification of hydronic piping system.
 - 6. Division 15 Section "Mechanical Insulation" for pipe insulation.
 - 7. Division 15 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic systems.
 - 8. Division 15 Section "Automatic Temperature Controls" for temperature control valves and sensors.
 - 9. Division 15 Section "Testing, Adjusting and Balancing, Mechanical O&M Manuals" for procedures for hydronic systems adjusting and balancing.

1.3 DEFINITIONS

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

1.4 SYSTEM DESCRIPTION

- A. General: The hydronic piping system is the chilled water system and condenser water system.

1.5 SUBMITTALS

- A. Product Data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.
 - 1. Furnish flow and pressure drop curves for diverting fittings and calibrated plug valves, based on manufacturer's testing.
- B. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manuals.
- C. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.
- D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.
- E. Reports specified in Part 3 of this Section.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: comply with the provisions of the following:
 - 1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - 2. International Mechanical Code, current edition.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:
1. Grooved Mechanical Joint Pipe, Fittings, and Couplings:
 - a. Victaulic Company of America.
 - b. Gruvlok.
 - c. Central Sprink Inc.
 2. Balvalve Indicator and Flow Setters:
 - a. Gerand Engineering Co.
 - b. Preso Industries Ltd.
 - c. Taco "Accu-Flo."
 3. Automatic Flow Control Valves:
 - a. Flow Design, Inc.
 - b. Griswold Controls.
 4. Pump Discharge Valves (triple duty valves):
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 - d. Taco, Inc.
 5. Safety Relief Valves:
 - a. Amtrol, Inc.
 - b. Bell & Gossett ITT; Fluid Handling Div.
 - c. Spirax Sarco.
 - d. Watts Regulator Co.
 6. Pressure Reducing Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 - d. Taco, Inc.
 - e. Honeywell-Baukman.
 7. Air Vents (automatic):
 - a. Armstrong Machine Works.
 - b. Bell & Gossett ITT; Fluid Handling Div.
 - c. Hoffman Specialty ITT; Fluid Handling Div.
 - d. Spirax Sarco.
 - e. Honeywell-Baukman.

8. Pump Suction Diffusers:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett ITT; Fluid Handling Div.
 - d. Taco, Inc.
 - e. Victaulic Company of America
9. Dielectric Waterway Fittings:
 - a. Victaulic Company of America
10. Y-Pattern Strainers:
 - a. Armstrong Machine Works.
 - b. Hoffman Specialty ITT; Fluid Handling Div.
 - c. Metraflex Co.
 - d. Spirax Sarco.
 - e. Trane Co.
 - f. Victaulic Co. of America.
 - g. Watts Regulator Co.
11. Basket Strainers:
 - a. Crane Co.
 - b. Metraflex Co.
 - c. Spirax Sarco.
 - d. Victaulic Company of America
12. Flexible Connectors:
 - a. Amber-Booth.
 - b. Mason Industries, Inc.
 - c. Metraflex Co.

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.
- B. Steel Pipe: ASTM A 120 or ASTM A 53 Grade A or B, standard weight (std.) or extra strong weight (xs), seamless, black steel pipe, plane ends.

2.3 FITTINGS

- A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
- C. Grooved Mechanical Fittings: ASTM A 536, Grade 65-45-12 Ductile Iron; ASTM A 47 Grade 32510 Malleable Iron; ASTM A 53, Type F, or Types E or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.

- D. Grooved Mechanical Couplings: consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- E. Steel Flanges and Flanged Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt Welding.
 - 3. Facings: Raised face.
- F. Unions: ANSI B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.
- G. Dielectric Fittings: Assembly or fitting having insulating material; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.
- H. Flexible Connectors:
 - 1. Flexible neoprene connectors shall be manufactured of multiple plies of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two spheres. Connectors up to and including 1-1/2" diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges. Hoses shall be installed on the equipment side of the shut-off valves.
 - 2. Connectors shall be rated a minimum of 150 psi at 220 degrees F. Flanged equipment shall be directly connected to neoprene elbows in the size range 2-1/2" through 12" if the piping makes a 90 degree turn at the equipment. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. 12" and larger sizes operating above 100 psi shall employ control cables with end fittings isolated by means of 1/2" thick bridge bearing neoprene washer bushings designed for a maximum of 1,000 psi.

2.4 JOINING MATERIALS

- A. Welding Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- B. Gasket Material: thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.

2.5 GENERAL DUTY VALVES

- A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 15 Section "Valves." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.6 SPECIAL DUTY VALVES

- A. Balvalve Indicator and Flow Setters 2" and Under: Differential-pressure fixed orifice flow element with ball valve for flow rate adjustment. Differential at required gpm not to exceed 25 inches w.g. Brass body calibrated orifice or venturi with brass fittings, threaded ends, attached tag with flow conversion data, and male quick connect fittings with shut-off valves. Quick connect fittings, Hansen Manufacturing series KH model B1-K11. Brass body ball valve, 400 psi, "Teflon" seats and stem seal, tight shut-off, tamper proof locking device.
- B. Flow Setters 2-1/2" and Larger: Venturi type flow meters with plug cock for flow rate adjustment. Refer to 15110 and 15122.
- C. Pump Discharge Valves (triple duty valves): 175 psig working pressure, 250 deg F maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged, screwed, or grooved joint connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.

2.7 HYDRONIC SPECIALTIES

- A. Automatic Air Vent: designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.
- B. Pump Suction Diffusers: cast-iron body, with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; 175 psig working pressure, 240 deg F maximum operating temperature; and complete with the following features:
 - 1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
 - 2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
 - 3. Disposable fine mesh strainer to fit over cylinder strainer.
 - 4. Permanent magnet, located in flow stream, removable for cleaning.
 - 5. Adjustable foot support, designed to carry weight of suction piping.
 - 6. Blowdown tapping in bottom; gage tapping in side.

- C. Pump Suction Diffusers (Grooved end): cast-iron body, with threaded connections for 2 inch and smaller, grooved connections for 2-1/2 inch and larger; 175 psig working pressure, 230 deg F maximum operating temperature; and complete with the following features:
1. Inlet vanes with length 2-1/2 times pump section diameter or greater.
 2. Cylinder strainer with 3/16 inch diameter openings, designed to withstand pressure differential equal to pump shutoff head.
 3. Disposable fine mesh strainer to fit over cylinder strainer.
 4. Permanent magnet, located in flow stream, removable for cleaning.
 5. Adjustable foot support, designed to carry weight of suction piping.
 6. Blowdown tapping in bottom; gage tapping in side.
- D. Y-Pattern Strainers: 125 psig working pressure cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2 inch and larger, threaded connections for 2 inch and smaller, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- E. Basket Strainers: 125 psig working pressure; high tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.
- F. T-Pattern Strainers: 125 psi working pressure, ductile iron or malleable iron body, grooved end connections, Type 304 stainless steel strainer basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

- A. Condensate Drain Piping:
1. Install Type L, drawn copper tubing with wrought copper fittings and solder joints for 2 inch and smaller, above ground, within building. Install Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground or within slabs.
 2. Slope for drainage 1 inch in 10 feet.
 3. Install vented P-trap at each fan system coil drain pan connection.
 - a. Construct and locate P-trap with sufficient height and/or elevation head to allow condensate to drain and seal to be maintained against or with fan pressure.
 4. Size condensate drain piping as follows:

a.	0 - 2	tons cooling	3/4"
b.	2 \geq 5	tons cooling	1"
c.	5 \geq 30	tons cooling	1-1/4"
d.	30 \geq 50	tons cooling	1-1/2"
e.	50 \geq 170	tons cooling	2"
f.	170 \geq 300	tons cooling	3"
g.	300 \geq 430	tons cooling	4"

- B. Chilled Water Cooling, Condenser Water, Blow-Down Drain Piping:
 - 1. Above Ground Piping: Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger or grooved end pipe and fittings. Standard weight (std) for all except condenser water. Extra strong weight (xs) for condenser water. Black steel pipe, except galvanized steel pipe for condenser water outside side above ground, in cooling tower, and in condenser water pump room.

3.2 PIPING INSTALLATIONS

- A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- H. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting consisting of 3/8" globe or ball valve mounted on 6" long nipple same size as piping with discharge piping and valve extended down to an accessible location and terminated with a male hose connection and cap.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 7 for special sealers and materials.
- J. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow. Except in tunnel. Provide automatic air vent with manual shut off valve on 10" pipe at reducer in tunnel.

- K. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side against wall.
- L. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main at 45°, except for up-feed risers which shall have take-off out the top of the main line at 45°.
- M. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- N. Install dielectric waterways to join dissimilar metals.
- O. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.
- P. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration producing equipment.
- Q. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve and cap in blow down connection of strainers.
- R. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings and specified in Division-15 Section "Expansion Compensation."
- S. Field apply protective coating to underground steel pipe joints and damaged areas per manufacturer's requirements and instructions.
- T. Install automatic temperature control valve, wells, flow devices, and other pipe mounted devices.

3.3 HANGERS AND SUPPORTS

- A. General: Hanger, supports, and anchors devices are specified in Division 15 Section "HANGERS AND SUPPORTS." Conform to the table below for maximum spacing of supports:
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.

- C. Install hangers with the following minimum rod sizes and maximum spacing:

<u>Nom. Pipe Size</u>	<u>Max. Span-Ft.</u>	<u>Min. Rod Size-Inches</u>
1	7	3/8
1-1/2	9	3/8
2	10	3/8
3	12	1/2
3-1/2	13	1/2
4	14	5/8
5	16	5/8
6	17	3/4
8	19	7/8
10	22	7/8
12	23	7/8

- D. Support vertical runs at each floor.

3.4 PIPE JOINT CONSTRUCTION

- A. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:
1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
 - a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- B. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."
- C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- D. Grooved Joints: Assemble joints in accordance with fitting manufacturers written instructions.

3.5 VALVE APPLICATIONS

- A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
1. Shut-off duty: use gate, ball, and butterfly valves.

2. Throttling duty: use globe, ball, and butterfly valves.
 3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
 4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.
- B. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- C. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- D. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
- E. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.
- F. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.
- G. Install manual air vent valves at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install pump discharge valves in horizontal or vertical position with stem in upward position. Allow clearance above stem for check mechanism removal.
- B. Install temperature control valves, separable wells, flow devices, and other pipe line mounted devices.

3.7 FIELD QUALITY CONTROL

- A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
1. Leave joints including welds uninsulated and exposed for examination during the test.
 2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 3. Flush system with clean water. Clean strainers.
 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Testing: Test hydronic piping as follows:
1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the that liquid.
 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code For Pressure Piping, Building Services Piping.
 5. After the hydrostatic test pressure has been applied for at least 30 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

3.8 ADJUSTING AND CLEANING

- A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
- B. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- C. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.9 COMMISSIONING

- A. Fill system and perform initial chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
 1. Open valves to full open position. Close coil bypass valves.

2. Remove and clean strainers.
3. Check pump for proper direction of rotation and correct improper wiring.
4. Set automatic fill valves for required system pressure.
5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Check operation of automatic bypass valves.
8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
9. Lubricate motors and bearings.

END OF SECTION 15181

SECTION 15185 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements of the following Division 15 Sections apply to this section:
 - 1. "Basic Mechanical Requirements."
 - 2. "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes the following types of HVAC pumps:
 - 1. Base-mounted, separately coupled, vertical type, double-suction pumps.
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 3 Section "Concrete Work" and Division 15 for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
 - 2. Division 15 Section "Meters and Gages" for temperature and pressure gages and connectors.
 - 3. Division 15 Section "Mechanical Vibration and Seismic Controls" for isolation pads.
 - 4. Division 15 Section "Automatic Temperature Controls" for interlock wiring between pumps, and between pumps and field installed control devices.
 - 5. Division 16 Section "Electrical Connections for Equipment" for power supply wiring including field-installed disconnects and required electrical devices.
 - 6. Division 16 Section "Motor Control Centers" for field-installed alternating current motor controllers.
 - 7. Division 15 Section "Motors."

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including certified performance curves of selected models indicating selected pump's operating point, weights (shipping, installed, and operating), furnished specialties, and accessories.

- C. Shop drawings showing layout and connections for HVAC pumps. Include setting drawings with templates, and directions for installation of foundation bolts and other anchorages.
- D. Wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance data for HVAC pumps for inclusion in Operating and Maintenance Manual.

1.4 QUALITY ASSURANCE

- A. Hydraulic Institute Compliance: Design, manufacture, and install HVAC pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Provide components complying with NFPA 70 "National Electrical Code."
- C. UL Compliance: Provide HVAC pumps which are listed and labeled by UL, and comply with UL Standard 778 "Motor Operated Water Pumps."
- D. NEMA Compliance: Provide electric motors and components that are listed and labeled NEMA.
- E. Single Source Responsibility: Obtain HVAC pumps from a single manufacturer.
- F. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of HVAC pumps, and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided deviations in dimensions and profiles and efficiencies do not change the design concept or intended performance as judged by the Architect.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store pumps in a dry location.
- B. Retain shipping flange protective covers and protective coatings during storage.
- C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- D. For storage times greater than 5 days, dry internal parts with hot air or a vacuum-producing device to avoid rusting internal parts. Upon drying, coat internal parts with a protective liquid, such as light oil, kerosene, or antifreeze. Dismantle bearings and couplings, dry and coat them with an acid-free heavy oil, and then tag and store in dry location.

- E. Comply with Manufacturer's rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Base-Mounted, Separately-Coupled, Double-Suction Pumps:
 - a. "VSC" Bell & Gossett, ITT to match existing pumps.

2.2 PUMPS, GENERAL

- A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.
- B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.
- C. Motors: See Division 15 Section 15055 "Motors."
 - 1. Efficiency: See Division 15 Section 15055 "Motors."
- D. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 BASE-MOUNTED, SEPARATELY-COUPLED, DOUBLE-SUCTION PUMPS

- A. General Description: Pumps shall be base-mounted, centrifugal, separately-coupled, double-suction, single-stage, bronze-fitted, axially split case design, and having an impeller mounted between bearings. Pump shall have vertical outlet and vertical inlet. Temperature and pressure ratings: 175 psig working pressure and 225 deg F continuous water temperature.
- B. Casings Construction: Cast iron, with ANSI B16.1, Class 125 flanged piping connections, threaded gage tappings at inlet and outlet flange connections, and threaded drain plug at the bottom of the volute.
- C. Impeller Construction: Statically, and dynamically balanced, closed, double-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft.
- D. Wear Rings: Replaceable, bronze.
- E. Pump Shaft and Sleeve: Steel shaft, with bronze sleeve.
- F. Pump Shaft Bearings: Grease-lubricated ball bearings contained in a cast iron housing.

- G. Seals: Mechanical seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.
- H. Pump Couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment; complete with metal coupling guard.
- I. Mounting Frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM B 36. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Motor mounting holes for field-installed motors shall be field-drilled.
- J. Motor: Flexible-coupled to pump, with adjustable alignment on mounting frame. Motor shall be for VFD application. See Division 15 Section 15055 "Motors."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of HVAC pumps.
- B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.
- C. Examine equipment foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 EQUIPMENT BASES

- A. Construct concrete equipment pads as follows:
 - 1. Form concrete pads using framing lumber with form release compounds. Chamfer top edge and corners of pad.
 - 2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.
 - 3. Place concrete and allow to cure before installation of pumps. Use Portland Cement conforming to ASTM C150, 3,000 psi compressive strength, and normal weight aggregate.

3.3 INSTALLATION

- A. General: Comply with the manufacturer's written installation and alignment instructions.

- B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- C. Install seismic restraint and vibration isolation specified in other Division 15 sections.
- D. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- E. Set base-mounted pumps on concrete equipment base. Disconnect coupling halves before setting. Do not reconnect couplings until the alignment operations have been completed.
 - 1. Support pump base plate in accordance to manufacturer instructions.
 - 2. Adjust the supports until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.

3.4 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.
 - 1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."
- B. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.
 - 1. Alignment tolerances shall meet manufacturers recommendations.

3.5 CONNECTIONS

- A. General: Install valves that are same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
- C. Install a shut-off valve on the discharge side of base-mounted pumps.
- D. Install shut-off valve on the suction side of base-mounted pumps.
- E. Install flexible connectors on the suction and discharge side of each base-mounted pump. Install flexible connectors between the pump casing and the discharge valves, and upstream from the pump strainer.

- F. Install pressure gages on the suction and discharge of each pump at the integral pressure gage tapings provided.
- G. Electrical wiring and connections are specified in Division 16 sections.
- H. Control wiring and connections are specified in other Division 15 sections.

3.6 FIELD QUALITY CONTROL

- A. Check suction lines connections for tightness to avoid drawing air into the pump.

3.7 COMMISSIONING

- A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:
 - 1. Lubricate oil-lubricated bearings.
 - 2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
 - 3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
 - 4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
- B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:
 - 1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
 - 2. Open the valve in the cooling water supply to the bearings, where applicable.
 - 3. Open the cooling water supply valve if the stuffing boxes are water-cooled.
 - 4. Open the sealing liquid supply valve if the pump is so fitted.
 - 5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.
 - 6. Open the recirculating line valve if the pump should not be operated against dead shutoff.
 - 7. Start the motor.
 - 8. Open the discharge valve slowly.
 - 9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
 - 10. Check the general mechanical operation of the pump and motor.
 - 11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

- C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same, except that the discharge gate valve is opened some time before the motor is started.
- D. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

END OF SECTION 15185

SECTION 15620 - FUEL-FIRED HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Gas-fired unit heaters.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 15 Section "Breechings, Chimneys, and Stacks" for vents for heaters.
 - 2. Division 15 Section "Control Systems" for control for heaters.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including weights, dimensions, metal gages, and data on features and components. Include plan and elevation views of units, minimum clearances, and data on ratings and capacities.
- C. Maintenance data for products for inclusion in "Operating and Maintenance Manual."
- D. Wiring diagrams from manufacturers detailing requirements for electrical power and control wiring for heaters. Include ladder-type wiring diagrams for interlock and control wiring required for field installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70, "National Electrical Code."

1.5 EXTRA MATERIALS

- A. General: Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Unit Heaters, Gas, Centrifugal Fan:
 - a. Hastings Fan, Inc.
 - b. Lennox Industries, Inc.
 - c. Modine Mfg. Co.
 - d. The Trane Co..
 - e. Reznor

2.2 FUEL-FIRED HEATERS, GENERAL

- A. Types, Minimum Ratings, Locations, and Mountings: As indicated.
- B. Gas-Fired Heaters and Accessory Items: NFPA 54, "National Fuel Gas Code."
 - 1. AGA Approval: Heaters design certified and labeled by the American Gas Association.
 - 2. Type of Gas: Heaters designed and built to burn natural gas with characteristics the same as those of the gas available at the Project site.
- C. Assembly and Wiring: Heaters factory assembled, piped, wired, and tested.
- D. Heater Electrical Rating: 115 V a.c. except as otherwise indicated.
- E. Centrifugal Fans: Factory-balanced, resilient-mounted, steel, belt driven with adjustable-pitch motor sheave except as otherwise indicated.
- F. Motors: Totally enclosed with internal thermal overload protection and complying with Division 15 Section "Motors," except as otherwise indicated.
 - 1. Heater Motors: Energy efficient types as defined in Division 15 Section "Motors."
- G. Concentric Terminal Vent Assembly: Combined combustion air inlet and power vent outlet. Include adapter assembly for connection to inlet and outlet pipes, and flanges for wall penetration.
- H. Control Transformer: Integrally mounted. 120 V a.c./24 V a.c.

2.3 GAS-FIRED UNIT HEATERS, HIGH EFFICIENCY

- A. General: Comply with ANSI Z83.8, "Gas Unit Heaters."
- B. Housing: Steel, with integral motorized vent exhauster and inserts for suspension mounting rods.

- C. Ignition: Electronically controlled spark with flame sensor.
- D. Burners: Cast iron or aluminized steel.
- E. Automatic Fan Thermal Switch: Delays fan start until discharge air is heated. Delays fan shutdown until air cools to comfort threshold.
- F. Heat Exchanger: Aluminized steel.
- G. Unit Fan Type: Centrifugal.
- H. Automatic Gas Control: Two-stage, 24 V a.c. valve.
- I. Separated Combustion Air Supply: Combustion and heat exchange chambers isolated from heated space atmosphere.
- J. Discharge Louvers: Independently adjustable horizontal blades.
- K. Discharge Louvers: 4-way, independently adjustable horizontal and vertical blades.
- L. arranged to serve as a drain pan.
- M. Outdoor Housing: Weatherproof steel cabinet with integral support inserts and removable bottom arranged to serve as a drain pan.
- N. Heat Exchanger: Aluminized steel.
- O. Heat Exchanger: Stainless steel.
- P. Burners: Aluminized steel with stainless-steel inserts.
- Q. Automatic Gas Control: Single-stage, 24 V a.c. valve.
- R. Automatic Gas Control: Two-stage, 24 V a.c. valve.
- S. Automatic Gas Control: Electronically modulated valve with integral operating control and terminals for external sensors. 24 V a.c.
- T. Automatic Gas Control: Mechanically modulated valve with full-fire bypass.
- U. Ignition: Standing pilot.
- V. Ignition: Electronically controlled spark with flame sensor.
- W. Power Venter: Integral, motorized centrifugal fan interlocked with gas valve.
- X. Internal Casing: Aluminized steel, arranged to contain air flow, with duct flanges at inlet and outlet.

- Y. approved for the purpose.
- Z. Heater Type: Gravity vented, power burner, with the following features:
 - 1. Burner/Ignition: Power gas burner with electric spark.
 - 2. Burner/Ignition: Stainless-steel burner cup and head with balanced rotor draft fan and direct sensing, silicon carbide hot surface ignition.
 - 3. Emitter Tube: Aluminized-steel or hot-rolled steel tubing.
 - 4. Venting: Connector at exit end of emitter tubing for vent pipe connection.
 - 5. Control: External thermostat.
 - 6. Outside Air Connection: Duct connection for combustion air to be drawn directly from outside by burner or draft fan. Provide a filter in air flow path.

2.4 TEMPERATURE CONTROL

- A. Wires and cables are specified in Division 16.
- B. Sensors, Components, and Wiring: Specified in Division 15 Section "Control Systems."

2.5 FINISHES

- A. External Casings and Cabinets: Baked enamel over corrosion-resistant treated surface.

PART 3 - EXECUTION

3.1 INSTALLATION AND CONNECTION

- A. Installation and connection of gas-fire heaters and associated fuel and vent features and systems installed and connected in accordance with NFPA 54, applicable local codes and regulations, and manufacturer's printed installation instructions.
 - 1. Connect gas piping in accordance with Division 15 Section "Natural Gas Systems."
 - 2. Furnish required vent piping, thimbles, fittings, flashings with unit as required for project to meet codes.
- B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is plumb and level.
 - 1. Spring hangers are specified in Division 15 Section "Vibration, Sound, and Seismic Control."
- C. Substrate Mounted Units: Provide supports connected to substrate. Secure units to supports.
- D. Install controls as specified in Division 15 Section "Control System."

3.2 IDENTIFICATION

- A. Identify heaters and connections in accordance with Division 15 Section "Mechanical Identification."

3.3 COMMISSIONING

- A. Test functions, operations, and control sequences and protective features. Adjust to assure operation is in accordance with design.
- B. Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 CLEANING AND ADJUSTING

- A. Cleaning: Upon completion of installation, inspect heaters and associated components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.
- B. Adjusting: Make burner and other unit adjustments for optimum heating performance and efficiency. Adjust heat distribution features, including louvers, vanes, shutters, dampers, and reflectors, to provide optimum heat distribution for objects, personnel, and spaces served.

3.5 DEMONSTRATION

- A. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of heaters and heater systems and to train Owner's personnel.
 - 1. Conduct training as specified under "Instructions to Owner's Employees" in the "Project Closeout" Section of these specifications.
 - 2. Schedule training with at least 7-day advance notification.

END OF SECTION 15620

SECTION 15625 - CENTRIFUGAL CHILLERS - WATER COOLED

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Related Sections:
 - 1. Refer to other sections of Division 15 for piping, specialties, pumps, valves, field-installed automatic temperature controls, vibration isolation, and field applied insulation.
 - 2. Refer to Division 3 for concrete specifications for equipment pads.
 - 3. Refer to Division 9 for painting specifications for field applied paint.

1.2 SUMMARY

- A. This Section specifies packaged, water cooled, hermetic centrifugal water chillers.

1.3 SUBMITTALS

- A. Product Data: Submit product data, including rated capacities, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field connection.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field installed.
- D. Maintenance Data: Submit maintenance and operating data. Include this data in maintenance manual.
- E. Quality Control Submittals:
 - 1. Submit certification of compliance with ASME, UL, ARI, AND ASHRAE fabrication requirements specified in Quality Assurance below.
 - 2. Submit certification of compliance with performance verification requirements specified in PART 2 of this Section.
 - 3. Submit quality control reports specified in PART 3 of this Section.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. ASHRAE Compliance: Fabricate and install centrifugal chillers to comply with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
 - 2. UL Compliance: fabricate centrifugal chillers to comply with UL 465 "Central Cooling Air Conditioners".
 - 3. ASME Compliance: fabricate and stamp centrifugal chillers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
 - 4. ARI Compliance: Comply with ARI Standard 550-90.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver chillers as a complete factory-assembled unit with protective crating and covering.
- B. Ship chillers in a deep vacuum in one of two pieces, depending upon size.
- C. Coordinate the delivery of the chiller in sufficient time to allow movement into the building.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- B. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 WARRANTY

- A. Provide 2 year complete chiller package warranty from date of substantial completion. Warranty to include all materials and labor. (see schedule of alternates for 5 year warrantee)

1.8 SOUND

- A. SOUND DATA - The Centrifugal Chiller Sound Pressure Level (SPL), in decibels (dB), with a reference pressure of 20 micropascals, shall not exceed the values listed in "a" below. All ratings shall be in accordance with ARI Standard 575-87, "Method of Measuring Machinery Sound Within Equipment Rooms."
 - 1. No reduction of entering condenser water or raising of leaving chilled water temperatures will be allowed in the SPL's. Making such a temperature adjustment does not represent the loudest operating condition the chiller will experience while on the job, and could mask sound problems that would otherwise occur. A minimum of 75% of the sound data points along the length of the machine shall be taken, and established as the minimum percentage of total possible points used to determine sound levels.

a. Table

<u>% Load</u>	<u>dB, A Weighted</u>
100	79
50	82
25	83

- B. Sound Pressure Test - The chiller (one of each size) shall have a sound test conducted at the factory prior to shipment to confirm the Sound Pressure Levels submitted. All data must be measured and presented in strict accordance with ARI Standard 575-87.
1. In the event that a chiller does not meet the submitted dBA sound pressure level, the manufacturer must, at his expense, provide sufficient attenuation to the machine to meet the submitted value. This attenuation shall be applied in such a manner that it does not hinder the operation or routine maintenance procedures of the chiller.
 2. If the unit cannot be modified to meet the submitted SPL levels, manufacturer will be required to provide engineering, materials, labor, and testing for jobsite attenuation to bring the sound levels to an acceptable level.

1.9 MAINTENANCE SERVICE

- A. Furnish complete service and maintenance of chillers for period of two years from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide centrifugal chillers from one of the following:
1. Carrier A/C Group; Carrier Corp.
 2. York Int'l.

2.2 UNIT DESCRIPTION

- A. Microprocessor-controlled liquid chiller shall use a single stage, centrifugal compressor using refrigerant HFC-134a only. Centrifugal chiller refrigerant shall not have a planned phase out date.

2.3 QUALITY ASSURANCE

- A. Chiller performance shall be rated in accordance with ARI Standard 550/590-98.

- B. Equipment and installation shall be in compliance with ANSI/ASHRAE 15 (latest edition).
- C. Cooler and condenser refrigerant side shall include ASME "U" stamp and nameplate certifying compliance with ASME Section VIII, Division 1 code for unfired pressure vessels.
- D. "A manufacturer's data report is required to verify pressure vessel construction adherence to ASME vessel construction requirements. Form U-1 as required per ASME code rules is to be furnished to the owner. The U-Form must be signed by a qualified inspector, holding a National Board Commission, certifying that construction conforms to the latest ASME Code Section VIII, Div. 1 for pressure vessels. The ASME symbol "U" must also be stamped on the heat exchanger. Vessels specifically exempted from the Scope of the Code must come with material, test, and construction methods certification and detailed documents similar to ASME U-1; further, these must be signed by an officer of the company."
- E. Chiller shall be designed and constructed to meet UL requirements and have labels appropriately affixed.
- F. Compressor impellers shall be dynamically balanced and over-speed tested by the manufacturer at a minimum of 120% design operating speed. Each compressor assembly shall undergo a mechanical run-in test to verify vibration levels, oil pressures, and temperatures are within acceptable limits.
 - 1. Each compressor assembly shall be proof tested at a minimum 232 psig (1600 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture. The leak test shall not allow any leaks greater than 0.5 oz/year of refrigerant.
- G. Entire chiller assembly shall be proof tested at 232 psig (1600 kPa) and leak tested at 185 psig (1276 kPa) with a tracer gas mixture on the refrigerant side. The leak test shall not allow any leaks greater than 0.5 oz/year of refrigerant. The water side of each heat exchanger shall be hydrostatically tested at 1.3 times rated working pressure.
- H. Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.
- I. On chillers with unit mounted compressor motor starters, chiller and starter shall be factory wired and tested together to verify proper starter operation prior to shipment.

2.4 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored and handled in accordance with manufacturer's instructions.
- B. Unit shall be shipped with all refrigerant piping and control wiring factory installed.

- C. Unit shall be shipped charged with oil and refrigerant HFC- 134a charge as specified on the equipment schedule.
- D. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, chiller model number, chiller serial number, and refrigerant used.

2.5 WARRANTY

- A. Warranty shall include parts and labor for entire chiller for 2 years after start-up.

2.6 EQUIPMENT

- A. General:
 - 1. Factory assembled, single piece, liquid chiller shall consist of compressor, motor, lubrication system, cooler, condenser, initial oil and refrigerant operating charges, microprocessor control system, and documentation required prior to start-up.
 - a. Unit Mounted starter will be wired and tested by chiller manufacturer.
- B. Compressor:
 - 1. One centrifugal compressor of the high performance, single-stage type.
 - 2. The open type impeller with machined shroud contours and impeller diameter optimize each compressor's efficiency for each specified application.
 - 3. A tunnel diffuser shall provide a highly efficient controlled diffusion ratio by means of individually contoured, machined-in channels of circular cross section.
 - 4. Compressor, motor, and transmission shall be hermetically sealed into a common assembly and arranged for easy field servicing.
 - 5. Internal compressor parts must be accessible for servicing without removing the compressor base from the chiller. Connections to the compressor casing shall use O-rings instead of gaskets to reduce the occurrence of refrigerant leakage. Connections to the compressor shall be flanged or bolted for easy disassembly.
 - 6. The high speed shaft thrust bearing shall be of the tilting pad, multi-shoe, Kingsbury type with individually replaceable shoes. The low speed shaft thrust bearing shall be of the tapered land type.
 - 7. Transmission shall be single ratio, single helical, parallel shaft speed increaser. Gears shall conform to AGMA Standards, Quality II.
 - 8. The compressor design shall include a balancing piston to offset impeller thrust forces. The gear thrust load shall act opposite to impeller thrust loads.
 - 9. The variable inlet guide vanes at the inlet to the impeller shall provide capacity modulation from 100% to 25% capacity, with 70 deg f minimum entering condenser water temperature, while also providing pre-whirl of the refrigerant vapor entering the impeller for more efficient compression at all loads.

10. Compressor shall be provided with a factory installed lubrication system to deliver oil under pressure to bearings and transmission. Included in the system shall be:
 - a. Hermetic motor-driven oil pump with factory installed motor contactor with overload protection.
 - b. Refrigerant-cooled oil cooler.
 - c. Oil pressure regulator.
 - d. Oil filter with isolation valves to allow filter change without removal of refrigerant charge.
 - e. Oil sump heater, 115/230 v 60 Hz controlled from unit microprocessor.
 - f. Oil reservoir temperature sensor with main control center digital readout.
 - g. Oil pump and motor for 380-480v, 3 ph, 60 Hz power source.
 - h. When factory mounted compressor motor starter is provided, all wiring to oil pump, oil heater, and controls shall be pre-wired in the factory and power shall be applied to check proper operation prior to shipment.
11. Compressor shall be fully field serviceable. Compressors which must be removed and returned to the factory for service shall be unacceptable.

C. Motor:

1. Compressor motor shall be of the hermetic, liquid refrigerant cooled, squirrel cage, induction type suitable for voltage shown on the equipment schedule. If open motors are used in place of refrigerant cooled motors, the manufacturer shall supply a curve of motor heat loss as a function of load to allow calculation of the additional ventilation or air conditioning load generated from the motor heat rejection. In addition, a mechanical room safety alarm, wiring, and chiller emergency shut down shall be included to prevent chiller operation if machine room temperature exceeds 104 °F (40° C).
2. Motor design speed shall be 3550 rpm (60 Hz).
3. Motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with the motor windings.
4. Motor stator shall be arranged for service or removal with only minor compressor disassembly and without removing main refrigerant piping connections.
5. Full load operation of the motor shall not exceed nameplate rating.
6. One motor winding (with one spare) temperature sensor shall be provided.
7. Low voltage motors (600 v or less) shall be suitable for connection to solid-state type reduced voltage starters.

D. Cooler and Condenser:

1. Cooler shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, steel shell and tube sheets with fabricated steel waterboxes.

- a. Waterbox shall be Nozzle-in-Head Waterbox.
 - b. Waterbox shall have standard Victaulic grooves.
 2. Condenser shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, steel shell and tube sheets with fabricated steel waterboxes.
 - a. Waterbox shall be Nozzle-in-Head Waterbox.
 - b. Waterbox shall have standard Victaulic grooves.
 3. Tubing shall be copper, high-efficiency type, with integral internal and external enhancement unless otherwise noted. Tubes shall be nominal 3/4-in. OD with nominal wall thickness of 0.025 in. measured at the root of the fin unless otherwise noted. Tubes shall be rolled into tube sheets and shall be individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity. Intermediate support sheet spacing shall not exceed 36 in. (914 mm).
 4. Waterboxes and nozzle connections shall be designed for 150 psig (1034 kPa) minimum working pressure unless otherwise noted. Nozzles should have grooves to allow use of Victaulic couplings or raised face flange connections.
 5. The tube sheets of the cooler and condenser shall be bolted together to allow for field disassembly and reassembly.
 6. A reseating type pressure relief valve shall be installed on each heat exchanger. If a non-reseating type is used, a backup reseating type shall be installed in series.
 7. Waterboxes shall have vents, drains, and covers to permit tube cleaning within the space shown on the drawings. A thermistor type temperature sensor with quick connects shall be factory installed in each water nozzle.
 8. Cooler shall be designed to prevent liquid refrigerant from entering the compressor.
 9. Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.
 10. The condenser shell shall include a FLASC (Flash Subcooler) which cools the condensed liquid refrigerant to a reduced temperature, thereby increasing the refrigeration cycle efficiency.
- E. Refrigerant Flow Control:
 1. To improve part load efficiency, liquid refrigerant shall be metered from the condenser to the cooler using a float-type metering valve to maintain the proper liquid level of refrigerant in the heat exchangers under both full and part load operating conditions.
- F. The float valve chamber shall have a bolted access cover to allow field inspection and the float valve shall be field serviceable.
- G. Fixed orifices shall be unacceptable.
- H. Controls, Safeties, and Diagnostics:
 1. Controls:

- a. The chiller shall be provided with a factory installed and wired microprocessor control center. The control center shall include a 16 line by 40 character liquid crystal display, 4 function keys, stop button, and alarm light. The microprocessor can be configured for either English or SI units.
- b. The chiller control system shall have the ability to interface and communicate directly to the building Medasys control system.
- c. The default standard display screen shall simultaneously indicate the following minimum information:
 - 1) Date and time of day
 - 2) 24 character primary system status message
 - 3) 24 character secondary status message
 - 4) Chiller operating hours
 - 5) Entering chilled water temperature
 - 6) Leaving chilled water temperature
 - 7) Evaporator refrigerant temperature
 - 8) Entering condenser water temperature
 - 9) Leaving condenser water temperature
 - 10) Condenser refrigerant temperature
 - 11) Oil supply pressure
 - 12) Oil sump temperature
 - 13) Percent motor Rated Load Amps (RLA)
 - 14) Condenser head pressure and head pressure output signal.
 - 15) Chiller KW
 - 16) Chiller load limit KW.
- d. The default screen shall be displayed unless another specific screen is requested. If, after viewing another screen and if there is no soft-key activity at the control console for 15 minutes, the display shall automatically revert to the default screen, and the back light will go off.
- e. The 4 function keys shall be software driven within the Status, Schedule, Set Point and Service menu structures (as described below):
 - 1) Status Function:
 - a) In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control center including:
 - i) Evaporator pressure
 - ii) Condenser pressure
 - iii) Bearing oil supply temperature
 - iv) Compressor discharge temperature
 - v) Motor winding temperature
 - vi) Number of compressor starts
 - vii) Control point settings
 - viii) Discrete output status of various devices

- ix) Compressor motor starter status
 - x) Optional spare input channels
- 2) Schedule Function:
 - a) The chiller controls shall be configurable for manual or automatic start-up and shut-down. In automatic operation mode, the controls shall be capable of automatically starting and stopping the chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting a minimum of two 365-day occupancy schedules. Each schedule shall allow a minimum of 8 separate occupied/unoccupied periods, any or all of which can be scheduled by individual day for any or all days of the week, with a separate schedule for holidays. Schedules shall allow specification of Daylight savings start/end and up to 18 user-defined holidays up to one year in advance (month, day, and duration in days). Display of the occupancy schedules shall be viewable on the CVC screen. Each schedule shall provide a means of configuring an occupancy timed override to permit a "one time extension" of an occupied period on the configured day. The controls shall also provide for chiller start-up and shutdown via remote contact closure from a customer supplied device or from a building management system software command.
- 3) Set Point Function:
 - a) The controls shall provide the capability to view and change the leaving chilled water set point, entering chilled water set point, and demand limit set point at any time during chiller operating or shutdown periods. The controls shall allow for the specifications of capacity control by either leaving chilled water or entering chilled water.
- 4) Service Function:
 - a) The controls shall provide a password protected service function which allows authorized individuals to:
 - i) View an alarm history file which shall contain the last 25 alarm/alert messages with time and date stamp. These messages shall be displayed in text form, not codes.
 - ii) Execute a chiller controls test function for quick identification of malfunctioning components
 - iii) View/modify chiller configuration
 - iv) View/modify chiller occupancy periods

- v) View/modify schedule holiday periods
 - vi) View/modify schedule override periods
 - vii) View/modify system time and date
- f. Network Window Function
 - 1) Each Chiller CVC shall be capable of viewing multiple point values and statuses from other like controls connected on a common network, including controller maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses for those points that are operator forcible. The CVC shall also have access to the alarm history file of all like controllers connected on the network.
- g. Capacity control shall be by means of variable inlet guide vanes located at the impeller inlet. Load modulation shall be from 100% to 15% of compressor full load under normal ARI conditions without the use of hot gas bypass. The guide vanes are precisely positioned by a PID (proportional-integral-derivative) control algorithm to ensure precise control ($\pm 0.5^{\circ}$ F [$\pm 0.3^{\circ}$ ° C]) of desired chilled water temperature without hunting or overshooting the set point.
- h. The microprocessor control system shall include a programmed sequence to meet prelube needs prior to machine start-up and during coast down after machine stop. The microprocessor shall automatically activate and interlock the chilled water pump, condenser water pump, and cooling tower fans upon chiller activation.
- i. Upon request to start the compressor, the control system shall start the chilled water pump, condenser water pumps and tower fans and verify that flows have been established. The controller shall then compare the entering/leaving chilled water temperature with the chilled water set point. If the chilled water temperature is less than the chilled water set point, the control system shall shut down the condenser water pump and wait for the cooling load to be established.
- j. A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, shall control the rate of guide vane opening to prevent a rapid increase in compressor power consumption. The controls shall allow configuration of the ramp loading rate in either degrees/minute of chilled water temperature pulldown or percent motor amps/minute. During the ramp loading period, a message shall be displayed informing the operator that the chiller is operating in ramp loading mode.
- k. The control system shall include 2 compressor cycle timers to protect the motor from rapid cycling, a 15 minute minimum start-to-start timer, and a 1 minute minimum stop-to-start timer. In addition, the compressor shall be inhibited from restarting if more

- than 8 manual starts within a 12 hour period have occurred unless manually reset to override the starts count.
- l. The control system shall automatically cycle the compressor off to minimize energy usage whenever the leaving chilled water temperature is the configured number of degrees below the desired chilled water set point (5 F {3C} default). The chilled water pump shall remain on and when the leaving chilled water temperature rises above the set point by a user-configured amount, the compressor shall automatically restart. During the shutdown period, a message shall be displayed informing the operator a recycle restart is pending.
 - m. The control system shall monitor line voltage and if loss of voltage, high or low line voltage, ground fault or single cycle dropout is sensed, the chiller shall shut down. Upon restoration of line voltage, if the auto-restart after power failure algorithm is enabled, the chiller shall automatically resume the mode of operation functioning prior to shutdown. No additional wiring shall be required.
 - n. The control center shall allow reset of the chilled water temperature set point based on any one of the following criteria:
 - 1) Chilled water reset based on an external 4 to 20 mA signal.
 - 2) Chilled water reset based on a remote temperature sensor (such as outdoor air).
 - 3) Chilled water reset based on water temperature rise across the evaporator.
 - o. If a chiller system manager control system is provided, reset function shall apply to the entire chiller plant manager control system. When reset is active, a message shall be displayed indicating the type reset in effect.
 - p. The control center shall limit amp draw of the compressor to the rated load amps or to a lower value based on one of the following criteria:
 - 1) Demand limit based on a user input ranging from 40% to 100% of compressor rated load amps
 - 2) Demand limit based on external 4 to 20 mA signal.
 - q. The controls shall be capable of being configured to soft stop the compressor. When the stop button is pressed or remote contacts open with this feature active, the guide vanes shall close to a configured amperage level and the machine shall then shut down. The display shall indicate "shutdown in progress."
 - r. The chiller shall be provided with head pressure control and 8" control valve to control condenser water flow. When chiller is on valve minimum position shall allow 10% flow. Valve shall shut when chiller is off.
2. Safeties:
- a. Unit shall automatically shut down when any of the following

conditions occur: (Each of these protective limits shall require manual reset and cause an alarm message to be displayed on the CVC screen, informing the operator of the shutdown cause.)

- 1) motor overcurrent
 - 2) over voltage*
 - 3) under voltage*
 - 4) single cycle dropout*
 - 5) bearing oil high temperature
 - 6) low evaporator refrigerant temperature
 - 7) high condenser pressure
 - 8) high motor temperature
 - 9) high compressor discharge temperature
 - 10) low oil pressure
 - 11) prolonged surge
 - 12) loss of cooler water flow
 - 13) loss of condenser water flow
 - 14) starter fault
 - 15) single phase protection
- b. Shall not require manual reset or cause an alarm if auto-restart after power failure is enabled.
- c. The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following parameters are outside their normal operating range:
- 1) high condenser pressure
 - 2) high motor temperature
 - 3) low evaporator refrigerant temperature
 - 4) high motor amps.
- d. During the capacity override period, a pre-alarm (alert) message shall be displayed informing the operator which condition is causing the capacity override. Once the condition is again within acceptable limits, the override condition shall be terminated and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shut down and a message shall be displayed informing the operator which condition caused the shutdown and alarm.
3. Diagnostics and Service:
- a. The control system shall execute a series of prestart checks whenever a start command is received to determine if pressures, temperatures, and timers are within pre-start limits, thereby allowing start-up to proceed. If any of the limits are exceeded, a text alert message shall be displayed informing the operator of the cause of the pre-start alert.
 - b. A self diagnostic controls test shall be an integral part of the control system to allow quick identification of malfunctioning components.

- c. Once the controls test has been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test shall automatically energize the chilled water pump, condenser water pump, and oil pump. The control system shall confirm that water flow and oil pressure have been established and require operator confirmation before proceeding to the next test. A guide vane actuator test shall open and close the guide vanes to check for proper operation. The operator manually acknowledges proper guide vane operation prior to proceeding to the next test.
 - d. In addition to the automated controls test, the controls shall provide a manual test which permits selection and testing of individual control components and inputs. A thermistor test and transducer test shall display on the CVC screen the actual reading of each transducer and each thermistor installed on the chiller. All out-of-range sensors shall be identified.
 - e. All sensors shall have quick disconnects to allow replacement of the sensor without replacement of the entire sensor wire. Pressure transducers shall be capable of field calibration to ensure accurate readings and to avoid unnecessary transducer replacement. Transducers shall be serviceable without the need for refrigerant charge removal or isolation.
- 4. Building Control System Interface:
 - a. The chiller control system shall interface and communicate directly to the building control system. The chiller shall be supplied with a chiller output data port module and Metasys input data port which shall translate the information in the chiller microprocessor to data which interfaces with the Johnson Metasys building management control system.
- I. Electrical Requirements:
 - 1. Electrical contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, and electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.
 - 2. Electrical contractor shall wire the chilled water pump, condenser water pump, and tower fan control circuit to the chiller control circuit.
 - 3. Chiller Manufacturer (or chiller manufacturer's service company) shall supply and install electrical wiring and devices required to interface the chiller controls with the building Metasys control system in the chiller plant.
 - 4. Electrical power shall be supplied to the unit at the voltage, phase, and frequency listed in the equipment schedule.
- J. Piping Requirements - Instrumentation and Safeties:
 - 1. Mechanical contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Gages shall be Marsh

- Master or equal with 4 1/2 in. nominal diameter face. Scale range shall be such that design values shall be indicated at approximately mid-scale.
2. Gages shall be installed in the entering and leaving water lines of the cooler and condenser.
 3. Chiller Manufacturer (or chiller manufacturer's service company) shall be responsible for furnishing and installing all required chiller related auxiliary cooling and vent piping and accessory wiring not shown on the contract drawings that are required for proper chiller operation.
- K. Vibration Isolation:
1. Chiller manufacturer shall furnish neoprene isolator pads for mounting equipment on a level concrete surface.
- L. Start-up:
1. The chiller manufacturer shall provide a factory-trained representative, employed by the chiller manufacturer, to perform the start-up procedures as outlined in the Start-up, Operation and Maintenance manual provided by the chiller manufacturer.
 2. After the above services have been performed, the same factory-trained representative shall be available for a period of classroom instruction not to exceed 8 hours to instruct the owner's personnel in the proper operation and maintenance of the chiller.
 3. Manufacturer shall supply the following literature:
 - a. Start-up, operation and maintenance instructions.
 - b. Installation instructions.
 - c. Field wiring diagrams.
 - d. One complete set of certified drawings.
- M. Field-Installed Accessories:
1. Discharge Line Sound Reduction Kit:
 - a. Unit manufacturer shall furnish a discharge line sound reduction kit that completely covers the compressor discharge pipe and reduces compressor noise.
- N. Factory-Installed Accessories:
1. The following accessories shall be factory installed.
 - a. Automatic Hot Gas Bypass:
 - 1) Hot gas bypass valve shall be furnished, and controls shall be factory installed.
 2. Cooler Tubes:
 - a. Provide 3/4-in. outside diameter copper tubes in the cooler that are internally/externally enhanced and have 0.025 in. (0.635 mm) wall thickness.
 3. Condenser Tubes:
 - a. Provide 3/4-in. outside diameter copper tubes in the condenser that are internally/externally enhanced and have 0.025 in. (0.635 mm) wall thickness.

4. Cooler Passes:
 - a. Provide the cooler with 2-pass configuration on the water side.
5. Condenser Passes:
 - a. Provide the condenser with 2-pass configuration on the water side.
6. Factory Performance Test:
 - a. Unit manufacturer shall provide a performance test per the latest version of ARI-550/590-98 test procedures.
7. Pumpout Unit:
 - a. A water cooled refrigerant pumpout system shall be factory installed on the chiller and pipe fitted at the factory. The pumpout system shall include a 2-hp compressor and drive, piping, wiring, and motor.
8. Provide Compressor Discharge Isolation Valve and Liquid Line Ball:
 - a. These items shall be factory installed to allow isolation of the refrigerant charge in the condenser for servicing the compressor.
9. A condenser head pressure controller and valve shall be provided, allowing chiller startup at condenser water temperatures as low as 45 degree Fahrenheit. Head pressure valve control shall provide for 10% minimum flow so condenser pump will not be dead headed. Valve shall close when chiller is off.
10. Provide power factor correction capacitors to provide 95% minimum power factor.

2.7 INSULATION

- A. Insulate evaporators and other cold surfaces to prevent condensation, with ambient humidity of 75 percent and dry-bulb temperature of 90 deg. F (32 deg. C), no air movement. Use the manufacturer's standard insulation material.

2.8 FACTORY FINISH

- A. Chiller manufacturer's standard factory-finish.
- B. Factory-applied, baked-on, alkyd enamel metal coating on assembled chiller, including exposed ferrous metal surfaces and factory installed insulation.

2.9 SOURCE QUALITY CONTROL

- A. Test and Inspect: Centrifugal chillers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- B. Performance Verification – Factory Performance Test:
 1. Chiller specified for the project shall be factory performance tested under 100%, 75%, 50% and 25% load conditions. The manufacturer shall supply a certified test report to confirm performance as specified. The performance test shall be conducted in accordance with ARI Standard 550-92 procedures and tolerances.

2. A additional point shall be tested with 100% chilled water flow, 50% condenser water flow, 100% load and 85 deg f entering condenser water.
 - a. The performance test shall be run with clean tubes in accordance with ARI 550-92 and must include the following:
 - 1) A downward temperature adjustment per Section A7.3 shall be made to the design leaving evaporator water temperature where necessary to adjust from the design fouling to the clean tube condition.
 - 2) An upward temperature adjustment per Section A7.3 shall be made to the design entering condenser water temperature where necessary to adjust from the design fouling to the clean tube condition.
 - 3) There shall be no exceptions to conducting the performance test with clean tubes and with temperature adjustments in Paragraph a and b, and obtain a test fouling factor of 0.0000 hr. sq. ft.°F/BTU.
 - 4) The factory test instrumentation shall be per ARI Standard 550, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (NIST).
 - 5) A certified test report of all data shall be submitted to the Engineer prior to shipping of chiller to the job site. Preprinted certification will not be acceptable. Certification shall be original copy.
 - 6) Equipment will be accepted if the test procedures and tolerances are in conformance with ARI Standard 550-92. If the equipment fails to perform within allowable tolerances, the manufacturer will be allowed to make necessary revisions to the equipment and retest as required. The manufacturer shall assume all expenses incurred by the Owner or Owner's Representative to witness the retest. In the event that these revisions do not achieve submitted performance, the following penalties will be imposed:
 - a) Capacity Test:
 - i) For each ton below the allowable capacity as set forth in ARI 550-92 of the design capacity, five hundred dollars (\$500.00) per ton will be deducted from the contract price.
 - ii) Allowable capacity = (1-tolerance) x design capacity; tolerance per ARI 550-92, Section 5.4.
 - b) Power Consumption Test: The Power consumption penalty for all load points shall be based upon the tolerance set forth in ARI 550-92. The power consumption penalty (P.C.P.) will be calculated based upon the following formula:

P.C.P. = Measured kW – (Measured Tons x Allowable kW/Ton*)x\$1000/kW

*Allowable kW/Ton = (1 + tolerance) x design kW/Ton; tolerance per ARI 550-92, Section 5.4.

- c) Total Performance Penalty: The total performance penalty will be the sum of Capacity Penalty and Power Consumption Penalty.
- 7) Equipment manufacturer shall not invoice for the centrifugal chiller(s) until successful completion of the performance test or acceptance of penalty deduction from the contract.

2.10 FACTORY WITNESS TEST

- A. All transportation, lodging and meal expenses shall be paid for by the chiller manufacturer for a total of (3) three test witnesses (Salt Lake Community College Representatives, DFCM Representative, and Design Engineer). The chiller manufacturer shall be responsible for Engineer's time involved at \$100/hr. for witness time and travel time.
- B. Test and Inspect: Centrifugal chillers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- C. Performance Verification:
 - 1. Rate centrifugal chillers in accordance with ARI 550 "Standard for Centrifugal or Rotary Water-Chilling Packages".
 - 2. Provide a Coefficient Of Performance (COP) for centrifugal chillers not less than that specified and not less than that prescribed by ASHRAE 90A "Energy Conservation in New Building Design".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install chillers in accordance with manufacturers installation instructions.
- B. Install chillers plumb and level, firmly anchored, and maintain manufacturer's recommended clearances for servicing and maintenance.
- C. Install vibration isolators to concrete pad with anchor bolts and secure chiller to vibration isolators.

3.2 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other sections of Division 15.

The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to machine to allow servicing and maintenance.
2. Chilled Water Piping: Connect inlet to evaporator with controller bulb well, shutoff valve, thermometer, strainer, flow switch pressure gage, and union or flange. Connect outlet to evaporator with shutoff valve, balancing cock, thermometer, pressure gage, and union or flange.
3. Condenser Water Piping: Provide flanged connections to condenser, arranged piping to allow removal of condenser heads. Connect inlet to condenser with shutoff valve, thermometer, plugged tee, and pressure gage. Connect outlet to condenser with shutoff valve, thermometer, drain line and shutoff valve, strainer, and plugged tee.
4. Vent Piping: Provide drain piping as indicated from rupture disc to suitable drain.
5. Electrical Wiring: Provide all field wiring not specified elsewhere. Comply with Division 16.

3.3 FIELD QUALITY CONTROL

- A. Provide the services, to include a written report, of a factory authorized service representative to supervise the field assembly of the components, installation, and piping and electrical connections.

3.4 DEMONSTRATION

- A. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
- B. Start-up Service:
 1. Evacuate, dehydrate, vacuum pump and charge with specified refrigerant, and leak test in accordance with manufacturer's instructions. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 2. Perform lubrication service, including filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer.
 3. Do not place chillers in sustained operation prior to initial balancing of mechanical systems for interface with chillers.
- C. Training:
 1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Review with the Owner's personnel, the data contained in the Operating and Maintenance Manuals.
 2. Schedule training with Owner through the Architect/ Engineer with at least 7 days prior notice.

END OF SECTION 15625

SECTION 15763 - FAN-COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes fan-coil units and accessories.

1.3 SUBMITTALS

- A. Product Data: Include specialties and accessories for each unit type and configuration.
- B. Shop Drawings: Submit the following for each fan-coil unit type and configuration:
 - 1. Plans, elevations, sections, and details.
 - 2. Details of anchorages and attachments to structure and to supported equipment.
 - 3. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Size and location of access panels in hard ceilings to provide access to concealed units.
 - 5. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section.
- E. Maintenance Data: For fan-coil units to include in maintenance manuals specified in Division 1. Include the following:

1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Airtherm Manufacturing Company.
 2. Carrier Corp.
 3. Engineered Air.
 4. International Environmental Corp.
 5. McQuay International.
 6. York International Corp.

2.2 CONFIGURATION

- A. Horizontal Units: An assembly including cabinet, filter, chassis, coil, drain pan, fan, and motor in blow-through configuration with hydronic cooling coil

2.3 MATERIALS

- A. Chassis: Galvanized steel, with flanged edges.

- B. Coil Section Insulation: 1-inch (25-mm) duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread rating of 25 and smoke-developed rating of 50 when tested according to ASTM E 84.
- C. Drain Pans: Galvanized steel, with connection for drain. Drain pan shall have a removable plastic liner and be insulated with polystyrene or polyurethane insulation. Drain pan and liner shall be formed to slope from all directions to drain connection.
- D. Cabinet: Galvanized steel, with removable panels.
 - 1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with cast-aluminum discharge grilles.
- E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on with manufacturer's standard paint, applied to factory-assembled and -tested fan-coil unit before shipping.

2.4 WATER COILS

- A. Primary Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and with manual air vent. Coils shall be rated for a minimum working pressure of 300 psig (2068 kPa) and a maximum entering water temperature of 275 deg F (135 deg C).

2.5 FAN

- A. Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel directly connected to or V-belt driven from motor.

2.6 FAN MOTORS

- A. Motors for Direct-Drive Units: (See division 15 Motors), with integral thermal-overload protection and resilient mounts.
- B. Motors for Belt-Drive Units: Open dripproof with hinged mount and adjustable motor pulley.
- C. Wiring Terminations: Match conductor materials and sizes of connecting power circuit. Connect motor to chassis wiring with plug connection.

2.7 ACCESSORIES

- A. Supply section with opposed blade damper
- B. Filters: ~~1-inch-~~ (25-mm-) thick, throwaway filters in fiberboard frames.

2.8 CONTROL SYSTEMS

- A. Automatic Temperature Control by Control Contractor.

2.9 SOURCE QUALITY CONTROL

- A. Test and rate units according to ARI 440.
- B. Test unit coils according to ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with rubber-in-shear vibration isolators (rubber hangers). Vibration isolators are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
- C. Install piping adjacent to machine to allow service and maintenance.
- D. Ground equipment.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing and report results in writing:
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

- A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. After installing units, clean fan-coil units internally according to manufacturer's written instructions.
- C. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 15763

SECTION 15825 - TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-15 Basic Mechanical Materials and Methods sections apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of terminal unit work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of terminal units required for project include the following:
 - 1. Fan-Coil units.
- C. Refer to other Division-15 sections for piping; ductwork; and testing, adjusting and balancing of terminal units.
- D. Refer to Division-16 sections for the following work.
 - 1. Power supply wiring from power source to power connection on terminal unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- E. Provide the following electrical work as work of this section, complying with requirements of Division-16 sections:
 - 1. Control wiring between field-installed controls, indicating devices, and terminal unit control panels.
 - a. Control wiring specified as work of Division-15 for Automatic Temperature Controls is work of that section.

1.3 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
 - 2. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
 - 3. ARI Compliance: Test and rate fan-coil units in accordance with ARI Standard 440 "Room Fan-Coil Air Conditioners".
 - 4. UL Compliance: Construct and install fan-coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units".

5. UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.
- B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Samples: Submit 3 samples of each type of cabinet finish furnished.
- E. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

PART 2 - PRODUCTS

2.1 FAN-COIL UNITS

- A. General: Provide fan-coil units having cabinet sizes, and in locations indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coils, fanboard, drain pan assembly, fans, housing, motor, filter and insulation.
- B. Chassis: Construct chassis of galvanized steel with flanged edges.
- C. Insulation: Faced, heavy density glass fiber.

- D. Cabinet: Construct of 18-ga steel removable panels, 16-ga front. Provide insulation over entire coil section. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.
- E. Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi working pressure, and leak test at 300 psi under water.
- F. Drain Pans: Construct of galvanized steel. Insulate with polystyrene or polyurethane insulation. Provide drain connection.
- G. Fans: Provide centrifugal forward curved double width wheels of galvanized steel in galvanized steel fan scrolls.
- H. Motors: Provide motors with integral thermal overload protection. Run test motors at factory in assembled unit prior to shipping. Provide quickly detachable motor cords.
- I. Filters: Provide 2" thick throwaway type filters in fiberboard frames.
- J. Accessories: Provide the following accessories as indicated and/or scheduled:
 - 1. Discharge Grille Panels: Provide 18-ga galvanized steel, double deflection grilles,
 - 2. Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.
 - 3. Ceiling hung mounting brackets
- K. Manufacturer: Subject to compliance with requirements, provide fan-coil units of one of the following:
 - 1. Carrier Corp.
 - 2. McQuay Inc.
 - 3. Trane (The) Co.
 - 4. York Div.; Borg-Warner Corp.

2.2 COILS

- A. General: Provide coils of size and in location indicated, and of capacities and having performance data as scheduled. Certify coil capacities, pressure drops, and selection procedures in accordance with ARI 410. Provide special protective coatings as indicated.
- B. Cooling Coils:
 - 1. Fins: Construct of continuous aluminum or copper configured plate-fin type with full fin collars for accurate fin spacing and maximum fin-tube contact.
 - 2. Tubes: Construct of 5/8" seamless, copper tubes, arranged in parallel pattern with respect to air flow.
 - 3. Casings: Construct of 16-ga continuous coated galvanized steel for coil heights 33" and smaller; 14-ga for coil heights over 33". Provide formed

- end supports and top and bottom channels. Provide 16-ga steel center tube support for coil lengths 42" to 96", 2 or more supports for coil lengths over 96".
4. Air Bypass Arrestor: Provide foam sealing strip located between casing channels and fins along top and bottom.
 5. U-Bends: Construct of 5/8" copper tubes, machine die-formed on each end to provide accurate fit for silver brazed joints.
 6. Testing: Proof test water coils at 300 psi and leak test at 200 psi under water. Proof test refrigerant coils at 450 psi and leak test at 300 psi under water; clean, dehydrate, and seal with dry nitrogen charge.
 7. Coil Types: Provide the following coil types as indicated, and as scheduled.
 - a. Cleanable and Drainable Water Coils: Provide close-grained gray cast-iron inlet, outlet, and removable headers. Bolt headers to flat steel plates and gaskets. Roll tubes into steel plates and headers.
 - b. Drainable Water Coils: Provide close-grained gray cast-iron inlet, outlet, and intermediate headers.
 - c. Standard Water Coils: Provide close-grained gray cast-iron inlet and outlet headers for coil heights 33" and smaller. Provide seamless copper tube headers for coil heights over 33".
 - d. Refrigerant Coils: Provide refrigerant distributor of venturi type with low pressure drop design, arranged for down feed and maximum of 12 circuits per distributor. Provide seamless copper tube suction header. Construct distributor tubes of 5/16" copper tube for R-12, 1/4" copper tube for R-22.
- C. Manufacturer: Subject to compliance with requirements, provide coils of one of the following:
1. Aerofin Corp.
 2. American Air Filter; Allis-Chalmers Co.
 3. Carrier Corp.
 4. Dunham-Bush, Inc.
 5. McQuay Inc.
 6. Trane (The) Co.
 7. York Div.; Borg-Warner Corp.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Install end caps where units butt against walls. Install access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.

3.2 INSTALLATION OF FAN-COIL UNITS

- A. General: Install fan-coil units as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate fan-coil units as indicated, coordinate with other trades to assure correct recess size for recessed units.
- C. Install piping as indicated.
- D. Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF COILS

- A. General: Install coils as indicated, and in accordance with manufacturer's installation instructions.
- B. Mount coils on steel supports to form banks or stacks as indicated, brace, secure to air intake chamber. Place in location to permit installation of bypass damper if required, provide steel baffles where required to prevent bypassing of air.
- C. Pitch coil casings for drainage, not less than 1/8" toward return connections, except where drainage feature is included in coil design.
- D. Provide for each bank of cooling coils, stainless steel drain pan under each coil supported off of floor of sufficient height to allow installation of condensate trap to allow drainage of condensate from pan when installed on suction side of fan.
- E. Provide for each steam coil unit, steam supply connection with strainer, gate valve, automatic temperature regulating valve, condensate return connection with vacuum breaker, f & t trap, and gate valve, as indicated.
- F. Provide for each hot or chilled water coil unit, water supply, return connection, strainer, gate valves, automatic temperature regulating valve, balancing cocks, as indicated.

3.4 ELECTRICAL WIRING

- A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.5 ADJUSTING AND CLEANING

- A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

- B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. Install new filter units for terminals requiring same.

END OF SECTION 15825

SECTION 15838 - POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraphs titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

1. Available Manufacturers:

- a. Acme Engineering & Mfg. Corp.
- b. Ammerman Company, Inc./General Resource Corp.
- c. Breidert Air Products, Inc.
- d. Broan Mfg. Co., Inc.
- e. Cook, Loren Company.
- f. Greenheck Fan Corp.
- g. JennFan; Div. of Breidert Air Products, Inc.
- h. Penn Ventilation Companies, Inc.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; one-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
 3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Built-in cant and mounting flange.
 2. Overall Height: 12 inches (300 mm).
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Burglar Bars: 5/8-inch- (16-mm-) thick steel bars welded in place to form 6-inch (150-mm) squares.

2.3 MOTORS

- A. Refer to Division 15 Section "Motors" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: Open dripproof.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.
- B. Install units with clearances for service and maintenance.
- C. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Shut unit down and reconnect automatic temperature-control operators.
- D. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- E. Replace fan and motor pulleys as required to achieve design airflow.
- F. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

END OF SECTION 15838

SECTION 15971 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL CONDITIONS

1.1 GENERAL CONDITIONS

- A All pertinent sections of Section 15100, Division 15, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

1.2 SCOPE OF WORK

- A The scope of work shall include all labor, material, and equipment necessary to automate the new chiller with the existing central chiller system to replace the Business Building existing chiller.
- B The Building Automation System (BAS) shall be an extension of the existing Johnson Controls Metasys. The BAS shall incorporate Direct Digital Control (DDC) for equipment and direct communication to the Central Operator Workstation for remote monitoring and control.
- C All line and low voltage control wiring for the temperature control system shall be installed **in conduit** in accordance with the National Electric Code and Division 16 Specifications except that minimum 1/2" trade diameter conduit may be used.
- D This contractor shall carefully review all notes, coordination schedules, and drawings for work required under this section of the specification.
- E Adjustment and validation of control system. Instruction of Owner's representative on maintenance and operation of control equipment.
- F Composite diagrams showing interlocks between equipment furnished under this and other sections.
- G This system shall include but not be limited to controls and equipment as hereinafter specified:
1. Addition of a new Chiller
 2. Sequence integration with the existing chillers
 3. Fan Coil Unit and Unit Heater
 4. Exhaust Fans
 5. Pump start/stops/status
 6. Refrigerant Leak Detection System
 7. BTU Metering

1.3 EXECUTION

- A Related Work in Other Sections:
1. Examine all sections for work related to work of this section, principal items of which are:
 - a. Finish Division 9
 - b. Mechanical Division 15

- c. Electrical Division 16
- 2. The following incidental work shall be furnished by the designated contractor under the supervision of the Temperature Control Contractor:
 - a. The Mechanical Contractor shall:
 - 1) Install automatic valves, and separable wells that are specified to be supplied by the temperature control contractor.
 - 2) Furnish and install all necessary piping connections required for flow devices.
 - b. The Sheet Metal Contractor shall:
 - 1) Install all automatic dampers and provide necessary blank-off plates or transitions required to install dampers that are smaller than duct size.
 - 2) Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - 3) Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and fix and seal permanently in place only after stratification problems have been eliminated.
 - 4) Provide access doors or other approved means of access through ducts for service to control equipment.
 - c. The Electrical Contractor shall:
 - 1) Furnish and install line voltage power where shown on the Electrical drawings is furnished and wired by Division 16.
 - 2) Furnish and install 120 volt, 20 amp breaker for new ATC Panels. Refer to electrical power plan and mechanical drawings for location of ATC Panels.
 - 3) Furnish and install Metasys N2 compatible Variable Frequency Drive including all associated power wiring.
- B. Performance:
 - 1. The control system shall be an extension of the existing Johnson Controls Metasys Direct Digital Control System with remote monitoring and control at the campus Operator Workstations.
 - 2. Qualified Contractors: Johnson Controls Inc., Branch Office.
- C. Submittals:
 - 1. The following shall be submitted for approval:
 - a. Data sheets for all control systems and components.
 - b. Valve, damper, showing sizes, configuration capacity and location

of all equipment.

- c. Control system drawings containing pertinent data to provide a functional operating system, including a sequence of operation. Detailed shop drawings may be submitted in as-built form upon project completion.
- d. Submit six (6) complete sets of documentation.

D. Wiring:

- 1. Electric wiring and wiring connections required for the installation of the temperature control system as herein specified, shall be provided by the Temperature Control Contractor unless specifically shown on the drawings or called for in the specifications to be by the Electrical Contractor. Install wiring in accordance with the local and national electrical codes.
- 2. All cable shall be minimum 18 awg twisted shielded.

E. Instruction and Adjustment:

- 1. Upon completion of the project, the Temperature Control Contractor shall adjust and validate all thermostats, controllers, valves, damper operators, relays, etc. provided under this section.
- 2. Instruction manuals shall be furnished covering the function and operation of the control system on the project for use by the owner's operating personnel. An instruction period last not less than **three (3) hours** shall be provided to completely familiarize operating personnel with the temperature control system and direct digital controllers on the project.
- 3. Price shall include **eight hours** for system start-up and tuning with mechanical engineer, owner, and chiller manufacturer at the site.

F. Warranty:

- 1. Upon completion of the project as defined either by acceptance of the building by the Owner or by beneficial use of the equipment by the Owner, a warranty period of one year shall commence. The warranty shall consist of a commitment by the Automatic Temperature Control Contractor to provide at no cost to the Owner, parts and labor as required to repair or replace such parts of the temperature control system that prove inoperative due to defective materials or installation practices.

G. Project Completion Documentation:

- 1. Submit three (3) copies of operation and maintenance manuals including:
 - a. Manufacturer's catalog data and specification of sensors, controllers, valves, actuators and other components.
 - b. An operator's manual, which will include detailed instruction for all operation of systems.
 - c. A copy of the warranty letter.

- d. Control drawings with sequence of operation and bill of materials.
 - e. A list of operating and maintenance procedures.
 - f. Copy of all trend logs.
2. Submit three (3) copies of Instrument Check-Off sheets including:
- a. Installation verification of all I/O points signed and dated by the installer that performed the work.
 - b. Software verification check-off sheets verifying functional operation in accordance with the sequence of operation signed and dated by the technician that performed the work.

PART 2 - EQUIPMENT

2.1 OVERVIEW

- A A new chiller shall be added to the existing central chiller plant. The existing chiller stage software program shall be modified to meet the new operating sequences listed in Part 3 of this specifications. Furnish and install automatic temperature control devices to control the mechanical equipment being installed.

2.2 APPLICATION SPECIFIC CONTROLLERS (GENERAL)

- A Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. For primary staging of the new and existing chiller operating sequence, the ASC Controller shall be a DX-9100 series controller.
- B Each ASC shall have sufficient memory to support its own operating system and data bases including:
- 1. Generic Input/Output Monitor and Control
 - 2. Control Processes
 - 3. Energy Management Applications
- C Power Fail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

2.3 CENTRAL OPERATOR WORKSTATIONS

- A This contractor shall modify the existing operating software to monitor and control the mechanical hardware listed in Part 3 – Operating Sequences. The software programming point descriptors shall match the existing campus hardware descriptors. Prior to software programming, submit a point list of system operation to the maintenance staff for review and comments.

- B Upon substantial completion, this contractor shall perform a software back-up/save of the operating software. One back-up copy shall remain at the central operator workstation location, the other copy will be given to the Maintenance Director.

2.4 CONTROL PANELS

- A All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed control panels with hinged locking doors. All control devices for equipment located in exposed areas subject to outside weather conditions, shall be mounted inside waterproof enclosures.
- B Furnish and install a fused transformer and provide a 120V outlet in each panel.
- C Local control panels or Direct Digital Controller shall not be mounted on the fan plenum duct walls. To avoid vibration, panels shall be mounted on a solid bearing wall or temperature control contractor shall construct a pedestal.

2.5 TEMPERATURE SENSORS

- A Space sensors controlling Chiller Room Fan Coil Unit and Unit Heater shall be furnished with 1000 ohm sensor, cover. No temperature indication or setpoint required.
- B Chilled water supply and return water thermowells for all immersion sensors shall be stainless steel or brass.

2.6 CONTROL DAMPER

- A Motorized control dampers, unless otherwise specified elsewhere, shall be low leakage type Johnson Controls D-1300 Performance Dampers. Damper blades shall be 16 gage galvanized steel double skin constructed. Frame shall be constructed of minimum 16 gage galvanized steel hat channel with corner braces. Blade axles shall be 3/4" plated steel with stainless steel bearings. Provide replaceable EPDM or appropriate material blade seals and flexible stainless steel jam seals. The damper and seals shall provide a maximum leakage rate of 8 cfm/sf @ 1" W.C. pressure differential. The damper shall be rated to operate with differential pressures up to 14" WC. The damper linkage shall provide a linear flow or equal percentage characteristic as required
- B Control dampers shall be parallel or opposed blade type as scheduled on drawings.

2.7 DAMPER OPERATORS

- A Damper Operators: Damper actuators shall be sized with enough torque to open the damper when the associated unit is operating. Where required install

multiple dampers operators. Damper operators shall be electric with either proportional or incremental control.

2.8 CONTROL VALVES

- A Furnish butterfly isolation valves for the new chiller. Isolation valves for both chilled and condenser water shall be manufactured by BRAY Equipment. Isolation valves shall be 2-way butterfly valves, furnished with tight shut-off seals. Factory furnished and installed electric 4-20ma actuator.

2.9 BTU METERING

- A Dual turbine insertion flow sensor complete with all installation hardware necessary to enable insertion and removal of the flow meter without system shutdown. The dual turbine element shall have contra-rotating axial turbine elements, each with it's own rotating sensing system, and averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Flow meters shall be Onicon F-1200, no exceptions.
- B For BTU monitoring, provide an Onicon System-10-N2 microprocessor based thermal energy meter with LCD display, with associated temperature sensors and thermowells to monitor the chilled water supply and return temperature. BTU Meter shall be furnished with an internal N2 communication board to communicate directly with the existing Johnson Controls "Metasys" Building Automation System.

2.10 PROOF OF FLOW

- A. Proof of flow for all motors not controlled by variable speed drives shall be through current switches monitoring the motor load current.
- B. Digital input contacts shall be normally open (NO) or normally closed (NC) (field selectable) potential free, and be isolated from the system to avoid damage due to transients or induced noise.

2.11 REFRIGERANT LEAK DETECTION SYSTEM

- A The Gas Monitoring System shall monitor for Refrigerant R-134a. The monitor panel shall provide visual indicators when preset limits are exceeded. Relay outputs for alarms and control shall be provided. System shall be provided with a minimum of three (3) remote mounted gas detection sensors.
- B Monitor Unit Requirements
 - 1. Readout Display – A 2 line 200 character alpha numeric display for the purpose of displaying the gas concentration, diagnostics, set-up and calibration menu.
 - 2. Visual Alarm Indicators – All alarms shall be displayed on the front panel display.

3. Alarm Set Point Levels – Three separate alarm set point levels shall be provided. The set points shall provide drive signals to user interface relays.
 4. Relays Outputs – The alarm set point drive signals shall activate user relays. Provide one relay for each alarm setpoint level and one trouble relay.
 5. Audible Alarm – An internal unit audible buzzer sounds when one of the three preselected alarm conditions or trouble condition occurs.
 6. Remote Sensor Inputs – Shall be capable of monitoring a minimum of four (4) remote sensor inputs.
- C. Refrigerant sensing system shall utilize photoacoustic infrared (IR) technology to sense refrigerant gases at levels as low as 1 part per million. MSA Chillgard LE series or approved equal.

PART 3 - SEQUENCE OF OPERATION

3.1 CHILLER SEQUENCING

- A. Furnish new control devices, DDC controller, sensors, ATC Panel to control the new chiller being installed.
- B. Modify the existing chillers and new chiller operating sequence of operation to control all the chillers in accordance with the operation listed below.
 1. From the Central OWS, the local operator shall select which of the three (3) chillers shall operate in a Lead/Lag sequence. Only two chillers shall be able to operate. The chiller not selected shall remain off with associated isolation valve closed and chilled water pump off.
 2. Lead chiller shall start when the outside air temperature is 60°F or above.
 3. Demand Limiting: The existing campus utility meter, located in the central heating plant, shall be monitored by the Building Automation System (BAS).
 4. On lead chiller start command the following will take place:
 - a. Campus target peak demand (as determined by campus operator for each month) minus campus demand (as determined by monitoring the campus electric pulse meter) prior to chiller startup shall determine the chiller maximum loading. Lead Chiller Demand Limit (% load limit) shall be sent to limit capacity of lead chiller.
 - b. If chilled water supply temperature (CWST) set point (45 deg f) is exceeded for more than 30 minutes (adjustable) then chiller shall be allowed to gradually load to 100% to maintain chiller set point (45 deg f)
 - c. When lead chiller load reaches 90 percent lag chiller shall be started and gradually load. At same time lead chiller demand limit will be reduced to 40 percent. When lag chiller chilled water supply temperature reaches set point (45 deg f) then lead chiller

demand limit will allow lead chiller to load to maintain set point.
(45 deg f)

5. When the lead chiller is started, open the associated isolation valve and start the chilled water pump.
6. The lead chilled water pump VFD shall ramp up to 50% minimum speed. After 60 seconds the local DDC controller will monitor the existing Differential Pressure sensor and modulate the VFD to maintain –1 psig differential pressure.
7. Start the lead condenser water pump, open the associated condenser water isolation valve. The condenser water isolation valve shall be modulated to control chiller head pressure. The chiller manufacture shall furnish from each chiller a 4-20ma signal for head pressure control. ATC Contractor shall wired from chiller terminal strip to valve.
8. The local DDC controller shall monitor the condenser water temperature. Cycle the cooling tower 2 speed fan motor to maintain 65°F condenser water temperature.
9. The internal chiller controls shall maintain 45°F chilled water supply temperature.
10. Through communication between the chiller integration module and JCI integrator, when the lead chiller is nearing 90% load capacity for 60 seconds, the second (lag) chiller shall be started and the lead chiller shall be staged back to 45% operation.
11. When Lag chiller is enabled to start, the associated chilled water and condenser water isolation valves shall open, chilled water pump start and condenser water through the chillers will reduce to 50% through each chiller (condenser water pumps to be controlled lead lag). The chiller internal controls shall allow the chillers to load to 45%. Condenser isolation valve shall be controlled by the chiller head pressure control. The DDC controller shall check the current utility meter KW, if KW usage is below target setpoint and the chilled water temperature is below 46°F, the DDC shall release the chillers to internally ramp up to maintain chiller water setpoint while being limited to not exceed the campus target peak demand. Should the chilled water temperature rise above 46°F for more than 30 minutes (adjustable) regardless of the campus KW usage the chillers shall be released to ramp to 100% load.
12. The lag chiller chilled water pump shall be controlled in parallel with the lead chiller chilled water pump to maintain differential pressure by modulate their respective VFD.
13. When the chiller loads drop to 40% for 30 minutes (adjustable), the DDC controller will stop the lag chiller, close the chilled and condenser water isolation valves, stop the associated chilled water pump. The lead chiller internal controls shall maintain 45°F chilled water temperature.
14. Lag chiller shall not be allowed to restart for 20 minutes after shut down.

C. BTU TOTALIZATION

1. Totalize the existing chiller plant BTU meter and the new chiller plant BTU meter and provide read out on the OWS.
2. Provide a CWST and CWRT sensor in the 12 inch chilled water loop mains in the Technology building tunnel prior to any take offs from the chilled water plant to provide a common CWST and CWRT for the chiller plant.

3.2 NEW CHILLER

- A. The ATC Contractor shall furnish the following items for the new chiller:
 1. Chiller water isolation valve and wiring to DDC Controller
 2. Condenser water isolation/head pressure valve and interlock wiring
 3. Chilled water supply and return temperature sensors for remote OWS monitoring
 4. Chilled water pump interlock wiring and current status sensor
 5. Chiller integration (see below)
 6. Chilled water BTU Metering (see below)
 7. Refrigeration Leak Detection Panel and interlock wiring (see below)
 8. Old chiller control panel upgrade to provide head pressure control and demand limiting.

3.3 NEW CHILLER INTEGRATION

- A. The new chiller shall be furnished with a communication port and compatible interface software to directly communicate with the existing Johnson Controls Metasys Integrator Panel currently communicating to the existing Carrier Chillers. Should the new chiller not be able to directly communicate to the existing JCI Integration Panel, the chiller manufacturer shall be responsible for furnishing, installing and wiring a communication panel and a new JCI MIG-100 series Integration Panel.
- B. The ATC contractor shall wire from the existing chiller Integration Panel to the new chiller communication module and verify communication. Modify the central OWS software for remote monitor and control the new chiller.

3.4 FAN COIL UNIT:

- A. Furnish and install a local ASC controller to control the fan coil unit, coil pump, and unit heater in sequence to maintain space temperature. When enabled by the OWS, the local ASC shall monitor the chiller room space temperature. Should space temperature exceed setpoint (70°F) start the fan coil unit and coil pump and modulate the chilled water valve. Should the space temperature drop below the setpoint (65°F) the gas unit heater fan shall be cycled to maintain space temperature.

- B. Points monitored at the Central OWS are: Fan Coil Unit fan status, Coil Pump status, room space temperature, low and high room temperature, Unit Heater fan status.

3.5 REFRIGERANT LEAK DETECTION/CHILLER SHUTDOWN/EXHAUST FAN (EF-1)

- A. In the new chiller room, furnish, install and wire a Refrigerant Leak Detection Panel with multiple (2) leak detection sensors, dry alarm contact, and dry trouble contact. Furnish, install and wire an "Emergency Chiller Shutdown Switch" located by the chiller room entrance door.
- B. A local ASC controller shall monitor the Refrigerant Leak Detection alarm contacts, trouble contacts, and the Emergency Chiller Shutdown Switch.
- C. The electrical contractor will hardwire the Low Level Alarm contact to start Exhaust Fan (EF-1) and open the motorized outside air intake damper upon operation of the alarm contact or upon operation of the Emergency Purge Ventilation Switch as shown on the control wiring diagrams on the electrical drawings.
- D. Provide current sensor switch to indicate Exhaust Fan EF-1 status.
- E. Should the Refrigerant Alarm Contact or the Emergency Purge Ventilation Switch be energized, the local DDC controller will shutdown the fan coil unit and the unit heater and alarm the central OWS.
- F. Hardwire the Refrigerant Alarm Contact and Emergency Chiller Shutdown Switch to stop the chiller and chilled water pump.

3.6 BTU METERING

- A. Furnish to the Mechanical Contractor for installation, where shown on the construction drawings, a dual turbine insertion flow sensor complete with all installation hardware necessary to enable insertion and removal of the flow meter without system shutdown. Flow meters shall be Onicon F-1200, no exceptions.
- B. Furnish, install and wire the flow meter and associated chilled water supply and return temperature sensors to an Onicon System 10-N2 BTU Meter. Connect the BTU Meter to directly communicate to the Metasys Building Automation via the N2 communication module. Provide read on at the central OWS.

3.7 EXHAUST FAN (EF-2)

- A. EF-2 shall be started and stopped from the central OWS through a local ASC controller. When enabled the exhaust fan shall operate continuously for minimum ventilation

- B. Furnish and install a current sensor switch at the exhaust fan to monitor motor operating status at the central OWS.

3.8 EXISTING CHILLER MECHANICAL ROOM

- A. To integrate the new chiller operating sequences, this contractor shall upgrade the existing UNT controllers with a new DX-9100 controller. Revise the existing software programs to perform the operating sequence indicated above in the new chiller sequence.
- B. Remove the existing defective Refrigeration Leak Detection Panel in the existing chiller room. Replace with a new MSA Chillgard LE Series or approved equal Refrigeration Leak Detection Panel. Verify proper operation of the ventilation exhaust fan, intake damper, chiller equipment shutdown and emergency switches.
- C. Provide new 120 VAC operator for existing outside air intake damper in the existing Chiller Room. New operator will be connected to emergency power by the electrical contractor as shown on the control wiring diagrams on the electrical drawings. Remove existing 24 Volt control wiring and raceway to the existing motorized damper operator.
- D. The existing Carrier Chiller shall be upgraded, by this contractor, with a Demand Limit controller. Wire from this controller to the DX-9100 to allow for this chiller to be unloaded by adjusting a 4-20ma signal as required.
- E. Adjust existing cooling tower sump level controls as required for proper shut down start up and alarm levels to accommodate additional water to be stored in sump.

3.9 ALTERNATE #1 EXISTING BUSINESS BUILDING DEMOLITION and CONTROL

- A. The existing two (2) chilled water pumps and associated VFD's shall be reused. Verify the operating sequence controlling these VFD's by the existing Air Handling Unit Discharge Air Temperature. Modify the local DDC software program to make one (1) of the chilled water pumps as a standby pump should the primary pump fail, the DDC controller will switch control to the standby chilled water pump VFD.
- B. Remove unused controls, control wiring and control air tubing from the Business Building Chiller Room and Cooling Tower. Give to the owner any controls they desire to keep for spare parts.
- C. Remove the existing pneumatic sensors and control air lines from chilled water and condenser control valves back to the existing ATC Panel. Cap the air lines to prevent air leakage.

- D. Remove the Onicon flow meter and associated wiring located in the existing chilled water supply line. Note: **Do not remove the Onicon BTU Meter** and associated flow meter and temperature sensors.
- E. Remove the chiller control wiring back to the DDC Controller.
- F. Remove the existing control wiring from the condenser water pump and tower sump Warrick level controller. Mechanical Contractor will provide in floor cover plates in the locations where these devices were removed.
- G. Modify the existing DDC software program at the local controller and central OWS to remove these points from the system.
- H. Remove the existing chilled water pumps (2) differential pressures switches and associated wiring. Replace pump monitoring status with new current sensor switches, wire back to the local DDC controller.

3.10 SYSTEM TREND LOG COMMISSIONING

- A. Provide Trend Log Mapping For The Following:
 - 1. Existing Chiller Plant
 - a. Chiller # 1
 - 1. CWST, CWRT, CST, CRT,
 - 2. BTU METER CWST, CWRT, FLOW, BTU,
 - 3. CW PUMP #1 VFD FLOW,
 - 4. CONDENSER HEAD PRESSURE
 - 5. CHILLER KW
 - 6. CHILLER KW DEMAND SETTING
 - 7. CAMPUS KW
 - b. Chiller # 2
 - 1. CWST, CWRT, CST, CRT,
 - 2. BTU METER CWST, CWRT, FLOW, BTU,
 - 3. CW PUMP #1 VFD FLOW,
 - 4. CONDENSER HEAD PRESSURE
 - 5. CHILLER KW
 - 6. CHILLER KW DEMAND SETTING
 - 2. New Chiller Room
 - a. New Chiller # 1
 - 1. CWST, CWRT, CST, CRT,
 - 2. BTU METER CWST, CWRT, FLOW, BTU,
 - 3. TUNNEL CWST, CWRT,
 - 4. CW PUMP #1 VFD FLOW,
 - 5. CONDENSER HEAD PRESSURE
 - 6. CHILLER KW
 - 7. CHILLER KW DEMAND SETTING
 - 3. Business Building
 - a. Existing Fan Unit

1. BTU METER CWST, CWRT, FLOW, BTU, SAT,
 - b. Existing Pumps
 1. VFD % FULL KW
 2. VFD % FULL KW
4. Technology Building
 - a. Existing Bypass Differential Pressure PSI.
 - b. BTU METER CWST, CWRT, FLOW, BTU,
5. College Center Building
 - a. BTU METER CWST, CWRT, FLOW, BTU,
6. Administration Building
 - a. BTU METER CWST, CWRT, FLOW, BTU,
7. Construction Trades Building
 - a. BTU METER CWST, CWRT, FLOW, BTU,

END OF SECTION 15971

**SECTION 15990 - TESTING, ADJUSTING, AND BALANCING; MECHANICAL
O&M MANUALS; AND SYSTEMS COMMISSIONING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Related sections include the following:
 - 1. Division 1 Section "Quality Control" for (general requirements of testing agencies).
 - 2. Division 15 Sections specify balancing devices and their installation, and materials and installations of mechanical systems.
 - 3. Division 15 system sections specifying leak testing requirements and procedures.

1.2 SYSTEM AIR & WATER BALANCE & TESTING

- A. Division 15 shall be responsible for the mechanical system balancing and manuals and shall include in his bid the cost of a Professional Balancing Firm to do the work as outlined. The balancing work shall be under the direction of a Professional Engineer, NEBB--certified TAB supervisor--or AABC--certified TAB supervisor--with experience in balancing systems of similar types and size. Approved balancing companies are BTC Services, Diamond Test and Balance, and Certified Testing & Balancing.
- B. The balancing work shall include but not be limited to the following:
 - 1. All system air and water balance work and reports for the systems affected by the new work.
 - a. Loop chilled water system and building chilled water system for Chiller Plant, Business Building, Technology Building, College Center, Administration Building and Construction Trades Building.
 - b. Building Chilled water systems for the Business Building which consist of one built up air handler.
 - c. The loop chilled water system and building chilled water systems shall be balanced and commissioned in accordance with the commissioning description and spread sheet forms. The first measurements shall consist of readings with the equipment operating as shown in the spread sheet. These readings in spread sheet format shall be submitted to the engineer for review prior to setting final flows.
 - d. Condenser water flows shall be read in accordance with description and flows on the spread sheet.
 - e. After initial report is reviewed by the engineer flow settings shall

be made in accordance with the flows shown on the contract documents and as noted by the engineer on the initial reviewed submittal.

- C. The Control Installer to assist with problems related to the water balance and commissioning. The Plumbing Installer is to assist with problems related to the water balance and commissioning. The Balancing Firm shall provide all other manpower required to accomplish the balancing work.
- D. Professional Balancing Firm shall furnish all necessary tools, scaffolding and ladders that are required and shall provide all required instruments, record all readings and see that any necessary adjustments are made.
- E. Instruments shall be used and applied which are best suited to the system function being tested. Instruments shall be in first class state of repair and will have calibration certified prior to starting the job. Instruments shall be recalibrated during the balancing process if required to prove reliability.
- F. Prepare test report sheets coordinated with contract drawings and zone sketch.
- G. Make sure that all calculations and tests are based only on complete equipment data and on approved drawings.
- H. After all adjustments are made, a detailed written report shall be prepared and submitted for approval. Final acceptance will not be made until a satisfactory report is received and field verified.
- I. The Owner's representative will field verify the report in the following manner:
 - 1. Select points to be tested at random. (Quantity shall not exceed 10% of total.)
 - 2. Require Balancing firm to read the quantities in his presence.
- J. Fan Unit Balancing
 - 1. Sheaves and/or belts shall be exchanged as required to adjust the rpm of all fans so they handle specified air quantity.
 - 2. See commissioning trend log report requirements.
- K. Hydronic Balancing Procedures: Using system flow meters, the balancing firm shall adjust the quantity of fluid handled by each pump and supplied to each coil, chiller etc., to meet design requirements. Water quantities shall be balanced to within plus or minus 5% of design. See commissioning spread sheet for chilled water loop commissioning report requirements.
- L. Miscellaneous:
 - 1. All installed thermal overload protection shall be observed and noted in the data sheets. If the starter equipment is incorrect, such information shall be tabulated, including required size thermal overloads, and included in the report. If thermal overload protection is incorrect, it shall

- be the responsibility of the balancing firm to notify in writing the Contractor and Architect so that proper overload protection is installed.
2. It will be the responsibility of the balancing firm to work with the Control Contractor during the water system check outs. The balance firm shall verify the flows for supply, exhaust, and return systems.
 3. All balancing devices, i.e., dampers and valves, shall be clearly marked as to the final balanced position. Plug all test holes, replace access doors and belt guards.
 4. When deemed necessary by the Architect or Engineer, 24 hour space temperature recording shall be taken and any required partial re-balance of the system shall be performed without additional cost. If adjustments are required to produce other than design requirements shown on drawings because of job conditions, these adjustments shall be made without extra cost.

M. Report:

1. A bound report shall be provided in the Operation and Maintenance Manual which shall contain a general information sheet listing instruments used, method of balancing, altitude correction, and manufacturer's grille, register and diffuser data.
2. Provide equipment data sheets listing make, size, serial number, rating, etc., of all mechanical equipment, including fans, pumps, motors, starters and drives. Operating data shall include rotational speed, inlet and outlet pressures, pressure drop across filters, coils and other system components, pump heads and measured motor current and voltage.
3. Hydronic balancing data sheets shall list required temperature or pressure differentials used for balancing coils, chillers, condensers, etc. Sheets shall show in comparison final as-balanced versus design values.
4. The report shall outline any abnormal or notable conditions not covered in the above.
5. The report shall include all measurements made under the "System Checks" section.

1.3 CHILLER PLANT CONDENSER WATER FLOW COMMISSIONING

A. Set condenser water flow both chillers operating:

1. With two chillers running set flow through condensers so flow is proportional. One condenser should have balancing valve wide open.
2. Measure and record final flow through each condenser with both chillers operating.
3. Measure and record condenser water temperature entering and leaving condenser for each condenser.
4. Record chiller % load at time readings are taken.
5. There are three chillers. Three different tests as described above will be required so all operating conditions are covered.

B. Condenser water flow with one chiller on and one chiller off.

1. Measure and record flow through condenser of active chiller.

2. For each chiller record flow through condenser of active chiller.
- C. Submit preliminary report to engineer.
- D. After review by engineer make necessary adjustments. Repeat above measurements and record.

1.4 CHILLER PLANT CHILLED WATER FLOW COMMISSIONING

- A. Chilled Water Pumps With VFD.
 1. All building chilled water pumps should be on (100%) with all cooling valves full open before doing the following test:
 - a. With two chillers running and chilled water pump VFD at 60 hz (100%), set flow through chillers so flow is equal. One chiller should have balancing valve wide open.
 - b. Record the pressure drop through each chiller.
 - c. Measure and record final flow through each chiller with both chilled water pumps operating.
 - d. Contractor should check and record BTU meter flow measurement and pump triple duty valve flow.
 - e. Measure and record chilled water temperature entering and leaving chiller for each chiller.
 - f. Record chiller (% load) at time readings are taken.
 - g. Measure and record pressure and direction in chilled water by-pass loop in Technology equipment room.
 2. Chilled water flow with one chiller on and one chiller off. (All secondary building chilled water pumps should be off. The chiller pump and building pump manual valves closed so all flow must go through by-pass line in Technology building equipment room.)
 - a. Measure and record pressure and direction in chilled water by-pass loop in Technology equipment room.
 - b. Measure and record flow through off chiller. (Flow through off chiller should be 0.)
 - c. Measure and record flow through active chiller. ATC contractor should check BTU meter flow for this chiller with these readings.
 - d. Reverse chiller operation and repeat above.
 3. Submit preliminary report to engineer. All recordings should be put in spread sheet matrix indicating pumps that are on and valves that are closed when readings are taken. If the report indicates the above procedure was not followed measurements and recordings will have to be repeated at no cost to owner.
 4. After review by engineer make necessary adjustments. Repeat above measurements and record.

1.5 LOOP CHILLED WATER FLOW COMMISSIONING

- A. Loop chilled water flow commissioning shall be in accordance with valve and equipment operation as outlined in the spread sheet commissioning forms. Initial readings shall be taken before balancing adjustments are made. Submit initial report to Engineer for review and comment prior to making final adjustments. After final adjustments are made, prepare final balance forms. If tests are not made in accordance with valve and equipment settings shown in the spread sheet commissioning forms the test will need to be re-done at contractors expense.

1.6 OPERATION AND MAINTENANCE MANUALS

- A. General:
1. Division 15 shall be responsible for the Mechanical Operation and Maintenance Manuals and shall include costs for manuals in his bid.
 2. Provide five (3) copies of Operations and Maintenance Manuals to the Owner.
 3. Manuals must be approved by the Architect prior to turning them over to the Owner.
 4. The Manuals shall be prepared by the Balancing Contractor.
 5. Manuals shall also be provided in electronic form on Compact Disk.
- B. Binders:
1. Binders shall be Red Buckram binders with easy view metal for sheet size 11" X 8-1/2" with expandable metal capacity as required for the project, rivet through construction with library corners using #12 BB and lining with same materials as cover, front cover and back-bone foil stamped in white. Print as follows:

OPERATING & MAINTENANCE
MANUAL
FOR THE
(LIST PROJECT NAME)
(LIST PROJECT CONTRACTOR) CONTRACTOR
SPECTRUM ENGINEERS MECHANICAL ENGINEERS

2. Binders shall be as manufactured by Hiller Bookbinding or equal.
3. The master index sheet and each tabbed index sheet shall be AICO Gold-Line Indexes or equal.

- C. The manuals shall be organized as follows:

SECTION I: Start-Up & Operation

Contractors and Vendors
General System Description
Detailed Start-Up Procedure
Automatic Temperature Controls
Fire Sprinkler System

SECTION II: Maintenance Instructions

Plumbing & Piping
Heating & Ventilating
Maintenance & Lube Table

SECTION III: Balance & Test Report

Air Balance Report
Water Balance Report
Test Run Report
Equipment Data Sheets
System Checks
System Commissioning Check List

- D. The master index will list all items sequentially in the manual, including Section heading, sub-headings and groups of equipment.
- E. The Contractor's and Vendor's sheet will list the name, address and phone number of the Mechanical Contractor and his subcontractors. It shall also include a complete list of equipment used, with name, address and phone number of the vendor.
- F. The General System Description will consist of an overall general description of the Heating, Ventilating and Air Conditioning Systems and components.
- G. The Detailed Start-Up Procedure will cover the step-by-step startup procedure for each piece of mechanical equipment. It shall be coordinated with the actual equipment on the job such as switches, starters, relays, automatic controls, etc. It shall include precautions and controls that must be actuated for equipment to operate properly.
- H. The Automatic Temperature Controls shall include for each system and component the following:
1. Written sequence of operation
 2. Complete ATC Control diagrams
 3. Complete control panel diagrams

- I. The Maintenance Instructions shall consist of manufacturer's maintenance instructions for each piece of mechanical equipment installed. Instructions shall include installation; instructions, complete parts lists with numbers, recommended operation instructions, wiring diagrams, trouble shooting, maintenance and lubrication instructions and name of vendor.
- J. The maintenance and lube table shall be a summary list of the mechanical equipment requiring lubrication. It shall show the name of the equipment location and type and frequency of lubrication.
- K. The Balance and Test Reports shall be as specified in the Balance and Test Section.
- L. The Equipment Data Sheets shall be provided for each motor-driven piece of equipment. Use standard form with all pertinent information provided such as rated and measured amps, volts, RPM, pressure drops, etc.

1.7 SYSTEM COMMISSIONING

- A. The System Commissioning shall consist of field verifying and certifying that the mechanical system is properly installed and is fully operational.
- B. Mark each item on the check list either "Complete" or "Not Applicable." Prepare Check List similar to the following list. Under "General Items," check list shall be completed for each piece of equipment such as Pump P/1, Supply Fan SF/1, Relief Fan RF/1, etc. When System Commissioning is complete submit check list and written certification to Architect. The Final Mechanical Inspection shall not be scheduled until System Commissioning check list is acceptable to the Architect.
- C. Commissioning requirements and reports:
 - 1. Provide tests required in accordance with commissioning spread sheets

1.8 COMMISSIONING SPREAD SHEETS

- A. Commissioning spread sheet will be provided in addendum
- B. Check List:

Completed N.A.

1. General Items:		
Bearings Lubricated	<input type="checkbox"/>	<input type="checkbox"/>
Rotation Correct and Free	<input type="checkbox"/>	<input type="checkbox"/>
Correct Size Thermal Overload Installed	<input type="checkbox"/>	<input type="checkbox"/>
Shipping Restraints Removed	<input type="checkbox"/>	<input type="checkbox"/>
Equipment Secured in Place and		
Seismically Braced	<input type="checkbox"/>	<input type="checkbox"/>
Equipment Clean and Free of Debris	<input type="checkbox"/>	<input type="checkbox"/>

	Vibration Isolators Correctly Located with Proper Springs	<input type="checkbox"/>	<input type="checkbox"/>
	Motors Not Overloaded	<input type="checkbox"/>	<input type="checkbox"/>
	Equipment Nameplates Clean and Accessible	<input type="checkbox"/>	<input type="checkbox"/>
2.	Life Safety Items:		
	Systems Completely Tested and Signed Off by All Appropriate Authorities	<input type="checkbox"/>	<input type="checkbox"/>
	Pipe and Equipment Identified	<input type="checkbox"/>	<input type="checkbox"/>
	Valves Tagged	<input type="checkbox"/>	<input type="checkbox"/>
3.	Piping Systems:		
	All Service and Balancing Valves in Place, Open, & Accessible	<input type="checkbox"/>	<input type="checkbox"/>
	Air Vents in Place and System Free of Air	<input type="checkbox"/>	<input type="checkbox"/>
	Expansion Tank Properly Located and Charged with Air	<input type="checkbox"/>	<input type="checkbox"/>
	Air Eliminator Properly Located and Piped	<input type="checkbox"/>	<input type="checkbox"/>
	No Leakage in Piping Systems	<input type="checkbox"/>	<input type="checkbox"/>
	Water Treatment Systems in Service	<input type="checkbox"/>	<input type="checkbox"/>
	Thermometer Wells in Place and Properly Located Insulation Completed	<input type="checkbox"/>	<input type="checkbox"/>
	Pressure/Temperature Taps Installed	<input type="checkbox"/>	<input type="checkbox"/>
	System Completely Filled and Static Pressure Proper	<input type="checkbox"/>	<input type="checkbox"/>
	System Thoroughly Flushed and Clean	<input type="checkbox"/>	<input type="checkbox"/>
	Start-Up Strainers Removed	<input type="checkbox"/>	<input type="checkbox"/>
	Permanent Strainers Installed with Proper Sleeves Strainer Sleeves Clean	<input type="checkbox"/>	<input type="checkbox"/>
	Strainers Piped for Easy Removal of Sleeves. Service Valves in Place. No Insulation Over Caps.	<input type="checkbox"/>	<input type="checkbox"/>
	Dirt Pockets Installed	<input type="checkbox"/>	<input type="checkbox"/>
	Flow Measuring Stations in Place. Proper Flow Direction. Gauge Tappings Turned Up. Nameplate Accessible. Correct Piping Length from Disturbances.	<input type="checkbox"/>	<input type="checkbox"/>
4.	Pumps:		
	Motors Aligned and Secured	<input type="checkbox"/>	<input type="checkbox"/>
	Couplings Secured	<input type="checkbox"/>	<input type="checkbox"/>
	Flexible Connections Correct	<input type="checkbox"/>	<input type="checkbox"/>

	Pressure Gauge Properly Piped	<input type="checkbox"/>	<input type="checkbox"/>
	Minimum of Negative System Effect	<input type="checkbox"/>	<input type="checkbox"/>
	No Entrained Air in Suction Piping in an Open System	<input type="checkbox"/>	<input type="checkbox"/>
5.	Coils:		
	Piped Correctly. Counterflow and Water Flow Upward	<input type="checkbox"/>	<input type="checkbox"/>
	Fins Combed	<input type="checkbox"/>	<input type="checkbox"/>
	Provisions for Pressure and Temperature Measurement Provided	<input type="checkbox"/>	<input type="checkbox"/>
6.	Fans:		
	Correct V-Belt Drive Installed	<input type="checkbox"/>	<input type="checkbox"/>
	V-Belt Drive Aligned	<input type="checkbox"/>	<input type="checkbox"/>
	Drive Screws and Keyways Tight	<input type="checkbox"/>	<input type="checkbox"/>
	Proper Belt Tension	<input type="checkbox"/>	<input type="checkbox"/>
	Flexible Connection Properly Installed	<input type="checkbox"/>	<input type="checkbox"/>
	Belt Guards in Place	<input type="checkbox"/>	<input type="checkbox"/>
	Minimum of Negative System Effect	<input type="checkbox"/>	<input type="checkbox"/>
7.	Filters:		
	Clean, Specified Cells Installed	<input type="checkbox"/>	<input type="checkbox"/>
	No Bypass Around Filters	<input type="checkbox"/>	<input type="checkbox"/>
	Filter Gauge Installed and Calibrated	<input type="checkbox"/>	<input type="checkbox"/>
	Spare Cells on Site	<input type="checkbox"/>	<input type="checkbox"/>
8.	Automatic Control System:		
	Control System in Operation	<input type="checkbox"/>	<input type="checkbox"/>
	All Controls Installed, Piped and/or Wired	<input type="checkbox"/>	<input type="checkbox"/>
	Controls Set and Calibrated	<input type="checkbox"/>	<input type="checkbox"/>
	Control Sequence Verified (In Conjunction with Control Sub-contractor)	<input type="checkbox"/>	<input type="checkbox"/>
	Automatic Valves Properly Piped	<input type="checkbox"/>	<input type="checkbox"/>
	Automatic Dampers OK	<input type="checkbox"/>	<input type="checkbox"/>
	Tight Closing	<input type="checkbox"/>	<input type="checkbox"/>
	Smooth Operation	<input type="checkbox"/>	<input type="checkbox"/>
	Full Stroking	<input type="checkbox"/>	<input type="checkbox"/>
	No Air Leaks	<input type="checkbox"/>	<input type="checkbox"/>

END OF SECTION 15990

SECTION 15971 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL CONDITIONS

1.1 GENERAL CONDITIONS

- A All pertinent sections of Section 15100, Division 15, are a part of the work described in this section. Division 1 is a part of this and all other sections of these specifications.

1.2 SCOPE OF WORK

- A The scope of work shall include all labor, material, and equipment necessary to automate the new chiller with the existing central chiller system to replace the Business Building existing chiller.
- B The Building Automation System (BAS) shall be an extension of the existing Johnson Controls Metasys. The BAS shall incorporate Direct Digital Control (DDC) for equipment and direct communication to the Central Operator Workstation for remote monitoring and control.
- C All line and low voltage control wiring for the temperature control system shall be installed **in conduit** in accordance with the National Electric Code and Division 16 Specifications except that minimum 1/2" trade diameter conduit may be used.
- D This contractor shall carefully review all notes, coordination schedules, and drawings for work required under this section of the specification.
- E Adjustment and validation of control system. Instruction of Owner's representative on maintenance and operation of control equipment.
- F Composite diagrams showing interlocks between equipment furnished under this and other sections.
- G This system shall include but not be limited to controls and equipment as hereinafter specified:
 - 1. Addition of a new Chiller
 - 2. Sequence integration with the existing chillers
 - 3. Fan Coil Unit and Unit Heater
 - 4. Exhaust Fans
 - 5. Pump start/stops/status
 - 6. Refrigerant Leak Detection System
 - 7. BTU Metering

1.3 EXECUTION

- A Related Work in Other Sections:
 - 1. Examine all sections for work related to work of this section, principal items of which are:
 - a. Finish Division 9
 - b. Mechanical Division 15

- c. Electrical Division 16
- 2. The following incidental work shall be furnished by the designated contractor under the supervision of the Temperature Control Contractor:
 - a. The Mechanical Contractor shall:
 - 1) Install automatic valves, and separable wells that are specified to be supplied by the temperature control contractor.
 - 2) Furnish and install all necessary piping connections required for flow devices.
 - b. The Sheet Metal Contractor shall:
 - 1) Install all automatic dampers and provide necessary blank-off plates or transitions required to install dampers that are smaller than duct size.
 - 2) Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - 3) Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and fix and seal permanently in place only after stratification problems have been eliminated.
 - 4) Provide access doors or other approved means of access through ducts for service to control equipment.
 - c. The Electrical Contractor shall:
 - 1) Furnish and install line voltage power where shown on the Electrical drawings is furnished and wired by Division 16.
 - 2) Furnish and install 120 volt, 20 amp breaker for new ATC Panels. Refer to electrical power plan and mechanical drawings for location of ATC Panels.
 - 3) Furnish and install Metasys N2 compatible Variable Frequency Drive including all associated power wiring.
- B. Performance:
 - 1. The control system shall be an extension of the existing Johnson Controls Metasys Direct Digital Control System with remote monitoring and control at the campus Operator Workstations.
 - 2. Qualified Contractors: Johnson Controls Inc., Branch Office.
- C. Submittals:
 - 1. The following shall be submitted for approval:
 - a. Data sheets for all control systems and components.
 - b. Valve, damper, showing sizes, configuration capacity and location

of all equipment.

- c. Control system drawings containing pertinent data to provide a functional operating system, including a sequence of operation. Detailed shop drawings may be submitted in as-built form upon project completion.
- d. Submit six (6) complete sets of documentation.

D. Wiring:

- 1. Electric wiring and wiring connections required for the installation of the temperature control system as herein specified, shall be provided by the Temperature Control Contractor unless specifically shown on the drawings or called for in the specifications to be by the Electrical Contractor. Install wiring in accordance with the local and national electrical codes.
- 2. All cable shall be minimum 18 awg twisted shielded.

E. Instruction and Adjustment:

- 1. Upon completion of the project, the Temperature Control Contractor shall adjust and validate all thermostats, controllers, valves, damper operators, relays, etc. provided under this section.
- 2. Instruction manuals shall be furnished covering the function and operation of the control system on the project for use by the owner's operating personnel. An instruction period last not less than **three (3) hours** shall be provided to completely familiarize operating personnel with the temperature control system and direct digital controllers on the project.
- 3. Price shall include **eight hours** for system start-up and tuning with mechanical engineer, owner, and chiller manufacturer at the site.

F. Warranty:

- 1. Upon completion of the project as defined either by acceptance of the building by the Owner or by beneficial use of the equipment by the Owner, a warranty period of one year shall commence. The warranty shall consist of a commitment by the Automatic Temperature Control Contractor to provide at no cost to the Owner, parts and labor as required to repair or replace such parts of the temperature control system that prove inoperative due to defective materials or installation practices.

G. Project Completion Documentation:

- 1. Submit three (3) copies of operation and maintenance manuals including:
 - a. Manufacturer's catalog data and specification of sensors, controllers, valves, actuators and other components.
 - b. An operator's manual, which will include detailed instruction for all operation of systems.
 - c. A copy of the warranty letter.

- d. Control drawings with sequence of operation and bill of materials.
- e. A list of operating and maintenance procedures.
- f. Copy of all trend logs.
- 2. Submit three (3) copies of Instrument Check-Off sheets including:
 - a. Installation verification of all I/O points signed and dated by the installer that performed the work.
 - b. Software verification check-off sheets verifying functional operation in accordance with the sequence of operation signed and dated by the technician that performed the work.

PART 2 - EQUIPMENT

2.1 OVERVIEW

- A A new chiller shall be added to the existing central chiller plant. The existing chiller stage software program shall be modified to meet the new operating sequences listed in Part 3 of this specifications. Furnish and install automatic temperature control devices to control the mechanical equipment being installed.

2.2 APPLICATION SPECIFIC CONTROLLERS (GENERAL)

- A Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. For primary staging of the new and existing chiller operating sequence, the ASC Controller shall be a DX-9100 series controller.
- B Each ASC shall have sufficient memory to support its own operating system and data bases including:
 - 1. Generic Input/Output Monitor and Control
 - 2. Control Processes
 - 3. Energy Management Applications
- C Power Fail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

2.3 CENTRAL OPERATOR WORKSTATIONS

- A This contractor shall modify the existing operating software to monitor and control the mechanical hardware listed in Part 3 – Operating Sequences. The software programming point descriptors shall match the existing campus hardware descriptors. Prior to software programming, submit a point list of system operation to the maintenance staff for review and comments.

- B Upon substantial completion, this contractor shall perform a software back-up/save of the operating software. One back-up copy shall remain at the central operator workstation location, the other copy will be given to the Maintenance Director.

2.4 CONTROL PANELS

- A All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed control panels with hinged locking doors. All control devices for equipment located in exposed areas subject to outside weather conditions, shall be mounted inside waterproof enclosures.
- B Furnish and install a fused transformer and provide a 120V outlet in each panel.
- C Local control panels or Direct Digital Controller shall not be mounted on the fan plenum duct walls. To avoid vibration, panels shall be mounted on a solid bearing wall or temperature control contractor shall construct a pedestal.

2.5 TEMPERATURE SENSORS

- A Space sensors controlling Chiller Room Fan Coil Unit and Unit Heater shall be furnished with 1000 ohm sensor, cover. No temperature indication or setpoint required.
- B Chilled water supply and return water thermowells for all immersion sensors shall be stainless steel or brass.

2.6 CONTROL DAMPER

- A Motorized control dampers, unless otherwise specified elsewhere, shall be low leakage type Johnson Controls D-1300 Performance Dampers. Damper blades shall be 16 gage galvanized steel double skin constructed. Frame shall be constructed of minimum 16 gage galvanized steel hat channel with corner braces. Blade axles shall be 3/4" plated steel with stainless steel bearings. Provide replaceable EPDM or appropriate material blade seals and flexible stainless steel jam seals. The damper and seals shall provide a maximum leakage rate of 8 cfm/sf @ 1" W.C. pressure differential. The damper shall be rated to operate with differential pressures up to 14" WC. The damper linkage shall provide a linear flow or equal percentage characteristic as required
- B Control dampers shall be parallel or opposed blade type as scheduled on drawings.

2.7 DAMPER OPERATORS

- A Damper Operators: Damper actuators shall be sized with enough torque to open the damper when the associated unit is operating. Where required install

multiple dampers operators. Damper operators shall be electric with either proportional or incremental control.

2.8 CONTROL VALVES

- A Furnish butterfly isolation valves for the new chiller. Isolation valves for both chilled and condenser water shall be manufactured by BRAY Equipment. Isolation valves shall be 2-way butterfly valves, furnished with tight shut-off seals. Factory furnished and installed electric 4-20ma actuator.

2.9 BTU METERING

- A Dual turbine insertion flow sensor complete with all installation hardware necessary to enable insertion and removal of the flow meter without system shutdown. The dual turbine element shall have contra-rotating axial turbine elements, each with it's own rotating sensing system, and averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Flow meters shall be Onicon F-1200, no exceptions.
- B For BTU monitoring, provide an Onicon System-10-N2 microprocessor based thermal energy meter with LCD display, with associated temperature sensors and thermowells to monitor the chilled water supply and return temperature. BTU Meter shall be furnished with an internal N2 communication board to communicate directly with the existing Johnson Controls "Metasys" Building Automation System.

2.10 PROOF OF FLOW

- A. Proof of flow for all motors not controlled by variable speed drives shall be through current switches monitoring the motor load current.
- B. Digital input contacts shall be normally open (NO) or normally closed (NC) (field selectable) potential free, and be isolated from the system to avoid damage due to transients or induced noise.

2.11 REFRIGERANT LEAK DETECTION SYSTEM

- A The Gas Monitoring System shall monitor for Refrigerant R-134a. The monitor panel shall provide visual indicators when preset limits are exceeded. Relay outputs for alarms and control shall be provided. System shall be provided with a minimum of three (3) remote mounted gas detection sensors.
- B Monitor Unit Requirements
 - 1. Readout Display – A 2 line 200 character alpha numeric display for the purpose of displaying the gas concentration, diagnostics, set-up and calibration menu.
 - 2. Visual Alarm Indicators – All alarms shall be displayed on the front panel display.

3. Alarm Set Point Levels – Three separate alarm set point levels shall be provided. The set points shall provide drive signals to user interface relays.
 4. Relays Outputs – The alarm set point drive signals shall activate user relays. Provide one relay for each alarm setpoint level and one trouble relay.
 5. Audible Alarm – An internal unit audible buzzer sounds when one of the three preselected alarm conditions or trouble condition occurs.
 6. Remote Sensor Inputs – Shall be capable of monitoring a minimum of four (4) remote sensor inputs.
- C. Refrigerant sensing system shall utilize photoacoustic infrared (IR) technology to sense refrigerant gases at levels as low as 1 part per million. MSA Chillgard LE series or approved equal.

PART 3 - SEQUENCE OF OPERATION

3.1 CHILLER SEQUENCING

- A. Furnish new control devices, DDC controller, sensors, ATC Panel to control the new chiller being installed.
- B. Modify the existing chillers and new chiller operating sequence of operation to control all the chillers in accordance with the operation listed below.
 1. From the Central OWS, the local operator shall select which of the three (3) chillers shall operate in a Lead/Lag sequence. Only two chillers shall be able to operate. The chiller not selected shall remain off with associated isolation valve closed and chilled water pump off.
 2. Lead chiller shall start when the outside air temperature is 60°F or above.
 3. Demand Limiting: The existing campus utility meter, located in the central heating plant, shall be monitored by the Building Automation System (BAS).
 4. On lead chiller start command the following will take place:
 - a. Campus target peak demand (as determined by campus operator for each month) minus campus demand (as determined by monitoring the campus electric pulse meter) prior to chiller startup shall determine the chiller maximum loading. Lead Chiller Demand Limit (% load limit) shall be sent to limit capacity of lead chiller.
 - b. If chilled water supply temperature (CWST) set point (45 deg f) is exceeded for more than 30 minutes (adjustable) then chiller shall be allowed to gradually load to 100% to maintain chiller set point (45 deg f)
 - c. When lead chiller load reaches 90 percent lag chiller shall be started and gradually load. At same time lead chiller demand limit will be reduced to 40 percent. When lag chiller chilled water supply temperature reaches set point (45 deg f) then lead chiller

demand limit will allow lead chiller to load to maintain set point.
(45 deg f)

5. When the lead chiller is started, open the associated isolation valve and start the chilled water pump.
6. The lead chilled water pump VFD shall ramp up to 50% minimum speed. After 60 seconds the local DDC controller will monitor the existing Differential Pressure sensor and modulate the VFD to maintain -1 psig differential pressure.
7. Start the lead condenser water pump, open the associated condenser water isolation valve. The condenser water isolation valve shall be modulated to control chiller head pressure. The chiller manufacture shall furnish from each chiller a 4-20ma signal for head pressure control. ATC Contractor shall wired from chiller terminal strip to valve.
8. The local DDC controller shall monitor the condenser water temperature. Cycle the cooling tower 2 speed fan motor to maintain 65°F condenser water temperature.
9. The internal chiller controls shall maintain 45°F chilled water supply temperature.
10. Through communication between the chiller integration module and JCI integrator, when the lead chiller is nearing 90% load capacity for 60 seconds, the second (lag) chiller shall be started and the lead chiller shall be staged back to 45% operation.
11. When Lag chiller is enabled to start, the associated chilled water and condenser water isolation valves shall open, chilled water pump start and condenser water through the chillers will reduce to 50% through each chiller (condenser water pumps to be controlled lead lag). The chiller internal controls shall allow the chillers to load to 45%. Condenser isolation valve shall be controlled by the chiller head pressure control. The DDC controller shall check the current utility meter KW, if KW usage is below target setpoint and the chilled water temperature is below 46°F, the DDC shall release the chillers to internally ramp up to maintain chiller water setpoint while being limited to not exceed the campus target peak demand. Should the chilled water temperature rise above 46°F for more than 30 minutes (adjustable) regardless of the campus KW usage the chillers shall be released to ramp to 100% load.
12. The lag chiller chilled water pump shall be controlled in parallel with the lead chiller chilled water pump to maintain differential pressure by modulate their respective VFD.
13. When the chiller loads drop to 40% for 30 minutes (adjustable), the DDC controller will stop the lag chiller, close the chilled and condenser water isolation valves, stop the associated chilled water pump. The lead chiller internal controls shall maintain 45°F chilled water temperature.
14. Lag chiller shall not be allowed to restart for 20 minutes after shut down.

C. BTU TOTALIZATION

1. Totalize the existing chiller plant BTU meter and the new chiller plant BTU meter and provide read out on the OWS.
2. Provide a CWST and CWRT sensor in the 12 inch chilled water loop mains in the Technology building tunnel prior to any take offs from the chilled water plant to provide a common CWST and CWRT for the chiller plant.

3.2 NEW CHILLER

- A. The ATC Contractor shall furnish the following items for the new chiller:
 1. Chiller water isolation valve and wiring to DDC Controller
 2. Condenser water isolation/head pressure valve and interlock wiring
 3. Chilled water supply and return temperature sensors for remote OWS monitoring
 4. Chilled water pump interlock wiring and current status sensor
 5. Chiller integration (see below)
 6. Chilled water BTU Metering (see below)
 7. Refrigeration Leak Detection Panel and interlock wiring (see below)
 8. Old chiller control panel upgrade to provide head pressure control and demand limiting.

3.3 NEW CHILLER INTEGRATION

- A. The new chiller shall be furnished with a communication port and compatible interface software to directly communicate with the existing Johnson Controls Metasys Integrator Panel currently communicating to the existing Carrier Chillers. Should the new chiller not be able to directly communicate to the existing JCI Integration Panel, the chiller manufacturer shall be responsible for furnishing, installing and wiring a communication panel and a new JCI MIG-100 series Integration Panel.
- B. The ATC contractor shall wire from the existing chiller Integration Panel to the new chiller communication module and verify communication. Modify the central OWS software for remote monitor and control the new chiller.

3.4 FAN COIL UNIT:

- A. Furnish and install a local ASC controller to control the fan coil unit, coil pump, and unit heater in sequence to maintain space temperature. When enabled by the OWS, the local ASC shall monitor the chiller room space temperature. Should space temperature exceed setpoint (70°F) start the fan coil unit and coil pump and modulate the chilled water valve. Should the space temperature drop below the setpoint (65°F) the gas unit heater fan shall be cycled to maintain space temperature.

- B. Points monitored at the Central OWS are: Fan Coil Unit fan status, Coil Pump status, room space temperature, low and high room temperature, Unit Heater fan status.

3.5 REFRIGERANT LEAK DETECTION/CHILLER SHUTDOWN/EXHAUST FAN (EF-1)

- A. In the new chiller room, furnish, install and wire a Refrigerant Leak Detection Panel with multiple (2) leak detection sensors, dry alarm contact, and dry trouble contact. Furnish, install and wire an "Emergency Chiller Shutdown Switch" located by the chiller room entrance door.
- B. A local ASC controller shall monitor the Refrigerant Leak Detection alarm contacts, trouble contacts, and the Emergency Chiller Shutdown Switch.
- C. The electrical contractor will hardwire the Low Level Alarm contact to start Exhaust Fan (EF-1) and open the motorized outside air intake damper upon operation of the alarm contact or upon operation of the Emergency Purge Ventilation Switch as shown on the control wiring diagrams on the electrical drawings.
- D. Provide current sensor switch to indicate Exhaust Fan EF-1 status.
- E. Should the Refrigerant Alarm Contact or the Emergency Purge Ventilation Switch be energized, the local DDC controller will shutdown the fan coil unit and the unit heater and alarm the central OWS.
- F. Hardwire the Refrigerant Alarm Contact and Emergency Chiller Shutdown Switch to stop the chiller and chilled water pump.

3.6 BTU METERING

- A. Furnish to the Mechanical Contractor for installation, where shown on the construction drawings, a dual turbine insertion flow sensor complete with all installation hardware necessary to enable insertion and removal of the flow meter without system shutdown. Flow meters shall be Onicon F-1200, no exceptions.
- B. Furnish, install and wire the flow meter and associated chilled water supply and return temperature sensors to an Onicon System 10-N2 BTU Meter. Connect the BTU Meter to directly communicate to the Metasys Building Automation via the N2 communication module. Provide read on at the central OWS.

3.7 EXHAUST FAN (EF-2)

- A. EF-2 shall be started and stopped from the central OWS through a local ASC controller. When enabled the exhaust fan shall operate continuously for minimum ventilation

- B. Furnish and install a current sensor switch at the exhaust fan to monitor motor operating status at the central OWS.

3.8 EXISTING CHILLER MECHANICAL ROOM

- A. To integrate the new chiller operating sequences, this contractor shall upgrade the existing UNT controllers with a new DX-9100 controller. Revise the existing software programs to perform the operating sequence indicated above in the new chiller sequence.
- B. Remove the existing defective Refrigeration Leak Detection Panel in the existing chiller room. Replace with a new MSA Chillgard LE Series or approved equal Refrigeration Leak Detection Panel. Verify proper operation of the ventilation exhaust fan, intake damper, chiller equipment shutdown and emergency switches.
- C. Provide new 120 VAC operator for existing outside air intake damper in the existing Chiller Room. New operator will be connected to emergency power by the electrical contractor as shown on the control wiring diagrams on the electrical drawings. Remove existing 24 Volt control wiring and raceway to the existing motorized damper operator.
- D. The existing Carrier Chiller shall be upgraded, by this contractor, with a Demand Limit controller. Wire from this controller to the DX-9100 to allow for this chiller to be unloaded by adjusting a 4-20ma signal as required.
- E. Adjust existing cooling tower sump level controls as required for proper shut down start up and alarm levels to accommodate additional water to be stored in sump.

3.9 ALTERNATE #1 EXISTING BUSINESS BUILDING DEMOLITION and CONTROL

- A. The existing two (2) chilled water pumps and associated VFD's shall be reused. Verify the operating sequence controlling these VFD's by the existing Air Handling Unit Discharge Air Temperature. Modify the local DDC software program to make one (1) of the chilled water pumps as a standby pump should the primary pump fail, the DDC controller will switch control to the standby chilled water pump VFD.
- B. Remove unused controls, control wiring and control air tubing from the Business Building Chiller Room and Cooling Tower. Give to the owner any controls they desire to keep for spare parts.
- C. Remove the existing pneumatic sensors and control air lines from chilled water and condenser control valves back to the existing ATC Panel. Cap the air lines to prevent air leakage.

- D. Remove the Onicon flow meter and associated wiring located in the existing chilled water supply line. Note: **Do not remove the Onicon BTU Meter** and associated flow meter and temperature sensors.
- E. Remove the chiller control wiring back to the DDC Controller.
- F. Remove the existing control wiring from the condenser water pump and tower sump Warrick level controller. Mechanical Contractor will provide in floor cover plates in the locations where these devices were removed.
- G. Modify the existing DDC software program at the local controller and central OWS to remove these points from the system.
- H. Remove the existing chilled water pumps (2) differential pressures switches and associated wiring. Replace pump monitoring status with new current sensor switches, wire back to the local DDC controller.

3.10 SYSTEM TREND LOG COMMISSIONING

- A. Provide Trend Log Mapping For The Following:
 - 1. Existing Chiller Plant
 - a. Chiller # 1
 - 1. CWST, CWRT, CST, CRT,
 - 2. BTU METER CWST, CWRT, FLOW, BTU,
 - 3. CW PUMP #1 VFD FLOW,
 - 4. CONDENSER HEAD PRESSURE
 - 5. CHILLER KW
 - 6. CHILLER KW DEMAND SETTING
 - 7. CAMPUS KW
 - b. Chiller # 2
 - 1. CWST, CWRT, CST, CRT,
 - 2. BTU METER CWST, CWRT, FLOW, BTU,
 - 3. CW PUMP #1 VFD FLOW,
 - 4. CONDENSER HEAD PRESSURE
 - 5. CHILLER KW
 - 6. CHILLER KW DEMAND SETTING
 - 2. New Chiller Room
 - a. New Chiller # 1
 - 1. CWST, CWRT, CST, CRT,
 - 2. BTU METER CWST, CWRT, FLOW, BTU,
 - 3. TUNNEL CWST, CWRT,
 - 4. CW PUMP #1 VFD FLOW,
 - 5. CONDENSER HEAD PRESSURE
 - 6. CHILLER KW
 - 7. CHILLER KW DEMAND SETTING
 - 3. Business Building
 - a. Existing Fan Unit

1. BTU METER CWST, CWRT, FLOW, BTU, SAT,
 - b. Existing Pumps
 1. VFD % FULL KW
 2. VFD % FULL KW
4. Technology Building
 - a. Existing Bypass Differential Pressure PSI.
 - b. BTU METER CWST, CWRT, FLOW, BTU,
5. College Center Building
 - a. BTU METER CWST, CWRT, FLOW, BTU,
6. Administration Building
 - a. BTU METER CWST, CWRT, FLOW, BTU,
7. Construction Trades Building
 - a. BTU METER CWST, CWRT, FLOW, BTU,

END OF SECTION 15971

SECTION 16000 - GENERAL PROVISIONS, ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions and Division 1 Specification Sections apply to work of this section and all other Division 16 specification sections.
- B. This section applies to all Division 16 specification sections.

1.2 SUMMARY

- A. This section includes general administrative and procedural requirements for electrical installations to expand the requirements of the General Conditions and Division 1 Specification Sections.

1.3 STANDARDS

- A. The following industry standards are considered minimum requirements for electrical work and are made a part of the contract documents:
 - 1. National Electrical Code, 2002 Edition (NEC)
 - 2. Electrical Ordinances of Local Governing Authority
 - 3. Utah State Fire Marshal's Rules and Regulations
 - 4. International Building Code
 - 5. International Fire Code
 - 6. Underwriters Laboratories (UL) Standards
 - 7. American National Standards Institute (ANSI)
 - 8. National Electrical Manufacturer's Association (NEMA)
 - 9. National Fire Protection Association (NFPA) Standards
 - 10. Regulations of American Standards Association
- B. If any conflict occurs between these rules and the contract documents or between the plans and specifications, notify the Project Engineer promptly in writing. Do not proceed with any work in conflict until a solution is approved in writing by the Project Engineer.

1.4 WORKMANSHIP

- A. All Electrical Work of any nature shall be performed by qualified electricians, experienced in the type of work to be performed and licensed with the State of Utah. Electricians shall show their license upon request of the Owner, Project Engineer and/or their representatives.

1.5 ELECTRICAL WORK INCLUDED

- A. The basic contract work includes all labor, material, tools, transportation, equipment, and superintendence specified, indicated on the drawings or necessary to make a complete installation of, but not limited to, the following:

1. Appliances, apparatus and materials not specifically noted on drawings or mentioned herein, but which are necessary to make a complete working installation of all electrical systems required for the project.
 2. Hangers, anchors, sleeves, chases, supports and fittings as may be required and as indicated.
 3. Complete electric service for new mechanical equipment with new breakers, starters, variable frequency drives and control equipment with branch circuits for power with raceway system and outlet boxes.
 4. Electrical connection of power to the controls of heating, ventilating and air conditioning equipment.
 5. All luminaires, wall switches, receptacles, etc. as indicated on drawings.
 6. Additions and connections to existing fire alarm system, complete with all equipment in operative condition.
- B. Include electrical work in Alternates as indicated on the drawings and Specification Section 01230.

1.6 SUBSTITUTIONS

- A. Material or products specified by name of manufacturer, brand or trade name or catalogue reference will be the basis of the bid and furnished under the contract unless changed in writing by the Project Engineer. Where two or more materials are named, the choice of these will be optional with the Contractor.
- B. Submit requests for substitution in writing to the Project Engineer in accordance with the General Conditions.

1.7 ACCURACY OF DATA

- A. Data given herein and on the drawings are as exact as could be secured, but their absolute accuracy is not guaranteed. Specifications and drawings are for the assistance and guidance of the Contractor.
- B. Electrical drawings are diagrammatic, but will be followed as closely as existing building construction and work of other contractors will permit. All deviations from the drawings required to make the Electrical Work conform to the existing buildings and to the work of other contractors will be made by the Contractor as approved by the Project Engineer.

1.8 VISIT THE SITE

- A. Contractors are assumed to have visited the site and thoroughly acquainted themselves with conditions affecting the proposed work. Verify existing conditions and measurements at the building before beginning work and immediately notify the Project Engineer of any discrepancies which may adversely affect completion of the work.

1.9 TEMPORARY POWER

- A. Provide temporary power for reasonable convenience during construction in accordance with the General Conditions.
- B. Provide GFCI Protection for all temporary power outlets.
- C. Use temporary power for construction purposes only. Do not use temporary power for electric space heating, etc..

1.10 SHOP DRAWING SUBMITTALS

- A. As soon as possible after contract award, submit shop drawings for review in accordance with the General Conditions and Division 1 Specifications.
- B. Submit shop drawings in three ring loose-leaf binder.
- C. Divide Electrical equipment into groups for each building and subsections of common equipment such as circuit breakers, starters, control equipment, variable frequency drives, etc.. Provide a complete equipment list at the beginning of each building group.
- D. Provide manufacturers' catalogue and/or descriptive literature indicating specific model and/or catalog numbers, options, accessories and modifications for the following items:
 - 1. Wiring Devices
 - 2. Circuit Breakers
 - 3. Motor Starters
 - 4. Purge Ventilation Control equipment and devices
 - 5. Variable Frequency Drives
 - 6. Fire Alarm System
- E. Above list is considered minimum. Additional items may be required to be submitted for review.
- F. Refer to individual Specification Sections for additional Shop Drawing Submittal requirements.

1.11 RECORD DRAWINGS

- A. Provide Electrical As-Built Record Drawings in accordance with the General Conditions and Division 1 Specifications.
- B. Indicate all changes made to the drawings such as changes in fixture and outlet location, changes in circuit routing and circuit numbering, etc. Include all changes by Addenda, Change Order, Supplemental Instruction or verbal instruction.
- C. Refer to individual Specification Sections for additional Record Drawing requirements.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance Manuals in accordance with the General Conditions

and Division 1 Specifications.

- B. Include manufacturers' catalog and/or descriptive literature of equipment actually installed. Clearly indicate on literature the specific model and/or catalog numbers of equipment installed, including all options, accessories and/or modifications.
- C. All copies of literature will be new, clean and clearly legible. Sheets used for shop drawing submittals with review stamp, remarks, etc., will not be acceptable.
- D. Divide Electrical equipment into subsections of common equipment such as starters, control equipment, variable frequency drives, etc.. Provide a complete equipment list and recommended maintenance schedule at the beginning of each subsection.
- E. Refer to individual Specification Sections for additional Operation and Maintenance Manual requirements.

1.13 WARRANTY

- A. Provide Warranty for Electrical Work in accordance with the General Conditions and Division 1 Specifications.
- B. Provide manufacturer's warranty for all equipment which the manufacturer normally provides a warranty in excess of twelve months. Refer to individual Specification Sections for extended warranty requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials and equipment for which U.L. Standards have been established, will be listed by and bear the label of Underwriters Laboratories, Inc..
- B. All materials will be new and bear the manufacturer's name, trade name and catalog or model numbers. Similar items will be of the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of materials will comply with all codes and be accomplished with good workmanship in the judgement of the Owner and Project Engineer.

3.2 COOPERATION WITH OTHER CONTRACTORS

- A. Cooperate with other contractors doing work on the building as may be necessary for the proper execution of the work of various trades employed in the construction.
- B. Refer to drawings, for construction details, and coordinate the electrical work with that of other contractors to the end that unnecessary delays and conflicts will be avoided.

3.3 MATERIAL HANDLING

- A. Use all means necessary to protect materials before, during and after installation and to protect the installed work and materials of all other trades.
- B. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Project Engineer and at no additional cost to the Owner.

3.4 CUTTING AND REPAIRING

- A. Provide all required digging, cutting, etc. incidental to the Electrical Work. Make required repairs thereafter to the satisfaction of the Project Engineer.
- B. Do not cut into any major structural element, beam or column, without written approval of the Project Engineer.
- C. Install the Electrical Work to proceed with other trades in order to avoid unnecessary cutting of the construction.

3.5 CONSTRUCTION REVIEW

- A. The Owner and/or Project Engineer will perform construction review throughout the construction of the project. The construction review does not relieve the contractor from the responsibility of providing all materials and performing the work in accordance with the Contract Documents.
- B. Notify the Project Engineer in writing, giving ample notice, at the following stages of construction and allow the Owner and/or Project Engineer to review the installed work.
 - 1. When all electrical rough-in is complete, but not covered.
 - 2. Pre-Final, upon completion of all electrical work.
 - 3. Final, upon completion of all items noted in the Pre-Final Construction Review Report.
- C. Prerequisite for Final Electrical Construction Review:
 - 1. Electrical Engineer/Consultant must be present.
 - 2. Electrical Contractor's job foreman must be present.
 - 3. DFCM Representative must be present.
 - 4. Salt Lake Community College Facilities Representative must be present.
 - 5. Service Disconnect and all Panelboard Enclosures must be open.
 - 6. Clear access must be provided to all devices and equipment.
 - 7. All panels, disconnects, etc. must be labeled and typed panel index cards installed.
 - 8. All receptacles, motors, etc. must be energized and operable.
 - 9. Contractor must have pad and pencil to list all deficient items.
 - 10. Make all corrections and adjustments after the Final Construction Review, not during. Items requiring correction will appear on the Final Construction Field Report.
 - 11. Contractor must have all required keys to provide access to all panels and doors.
- D. Test all systems and equipment provided and/or connected under the Contract for short

circuits, ground faults, proper neutral connections and proper operation in the presence of the Owner and Project Engineer.

- E. The entire construction will be installed in accordance with the contract documents and be free of mechanical and electrical defects prior to final acceptance of the work.

END OF SECTION 16000

SECTION 16060 - MINOR ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Remove electrical equipment and wiring systems and make required extensions and reconnections as shown on Drawings and specified herein.
- B. Repair all damage resulting from demolition and extension work.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Provide new materials and equipment for patching and extending work as specified in the appropriate Specification Section for the materials and equipment involved.
- B. Where materials or methods not included in the Specifications are required, provide materials and methods in accordance with normal construction industry standards and as approved by the Project Engineer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Field verify existing measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition Drawings are based on field observation of existing surface conditions and available existing building electrical drawings. Report discrepancies to the Project Engineer before disturbing existing installation.
- D. All demolition and extension work is not necessarily indicated on Drawings. Include all such work without additional cost to Owner.

3.2 PREPARATION

- A. Coordinate utility service outages with Salt Lake Community College Facilities Project Manager.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use

electricians experienced in such operations.

- C. Protect all existing electrical equipment, devices, etc., to remain from damage during demolition and new construction. Survey all existing equipment, devices, etc., prior to beginning work and document in writing and photograph any existing damage to existing equipment.

3.3 DEMOLITION

- A. Coordinate with Owner for equipment and materials to be removed by Owner or salvaged by the contractor for Owner.
 - 1. Place salvaged equipment and materials in storage at the owner's facility shop located at the northwest corner of the Salt Lake Community College Redwood Road Campus or as directed by the Owner.
- B. Legally dispose of all removed equipment and materials not salvaged for the Owner.
- C. Remove abandoned wiring to source of supply, i.e. panelboard, circuit breaker, etc..
- D. Remove accessible abandoned conduit, cables, junction boxes, etc., including above accessible ceilings. Cut conduit flush with walls and floors.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlet boxes and conduit servicing them where indicated on drawings. Provide blank cover for abandoned outlets which are not indicated to be removed.

3.4 EXTENSION OF EXISTING ELECTRICAL WORK

- A. Reconnect existing equipment where demolition interrupts existing branch circuits or feeders to the equipment.
- B. Repair adjacent construction and finishes damaged during demolition and extension work to match surrounding surfaces.
- C. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- D. Extend existing installations using materials and methods as specified for new work. Remove and replace existing installations which are not compatible with new work.

3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide new typed circuit directory showing revised circuiting arrangement.

3.6 INSTALLATION

- A. Install relocated materials and equipment as required for new materials and equipment.

3.7 OUTAGES

- A. Maintain Existing Electrical Systems in service until new systems are complete and ready for service. Disable systems only to make switchovers and connections. Minimize outage duration.
- B. Obtain permission from Owner and/or Project Engineer before partially or completely disabling systems in accordance with Division 1 Specification Sections.

END OF SECTION 16060

SECTION 16110 - RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide a complete raceway system for all wiring as shown on the drawings and as specified herein.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Provide minimum 3/4" trade diameter raceways for all wiring systems.
 - 1. Minimum 1/2" trade diameter raceways may be used for remote control, signaling and power-limited circuits which meet the requirements of National Electrical Code Article 725 as allowed in other Specification Sections and/or as approved by the Project Engineer.
- B. Do not use aluminum conduit, intermediate steel conduit (IMC), BX cable, MC cable, Flexible Non-metallic Tubing, NM cable, Direct Burial Cable or any other wiring methods not allowed by this specification unless approved in writing by the Project Engineer.

2.2 ABOVEGROUND RACEWAYS

- A. Provide Electrical Metallic Tubing (EMT), galvanized inside and out, for raceways not subject to permanent moisture or damage.
- B. Provide Galvanized Rigid Steel Conduit (GRC) where raceways are subject to permanent moisture such as underground, or damage such as vehicular traffic, etc..

2.3 FLEXIBLE RACEWAY CONNECTIONS

- A. Provide Flexible Steel Conduit for final connection to motors and other equipment subject to vibrations or movement, not to exceed 3 feet in length.
- B. Provide liquid-tight flexible steel conduit outside and in wet, humid, corrosive and oily locations.
 - 1. Provide Sunlight Resistant liquid-tight flexible steel conduit outdoors.
- C. Provide a ground conductor in all flexible steel conduit.
- D. Flexible Steel Conduit may be used where misalignment or cramped quarters exist only

with prior approval of the Project Engineer.

- E. Flexible Steel Conduit may be used to fish through existing walls and ceilings only with prior approval of the Project Engineer.

2.4 CONDUIT FITTINGS

- A. Provide steel compression type or steel set screw type fittings for Electrical Metallic Tubing.
- B. Provide malleable iron clamp type fittings for Flexible Steel Conduit.
- C. Provide steel compression type fittings for Liquid-Tight Flexible Steel Conduit.
- D. Provide threaded fittings for GRC conduit. Provide double locknuts and plastic bushing for GRC conduit terminations or provide boxes and enclosures with threaded hubs.
- E. Provide steel rain-tight, compression type fittings for all conduit installed outside and in wet, humid, corrosive and oily locations.
- F. Provide Insulated Throat Connectors for all conduit terminations 1" diameter and smaller. Provide insulating bushings for all conduit terminations 1-1/4" diameter and larger.
- G. Provide Grounding Bushings bonded to the electrical system ground:
 - 1. On each end of all feeder conduits in which a separate ground conductor is installed.
 - 2. On each end of all conduits used to protect ground conductors.
 - 3. On all conduit terminations installed in concentric or eccentric knockouts or where reducing washers have been installed.
- H. Do not use cast metal or indenter type fittings. Do not use screw-in type fittings for Flexible Steel Conduit.

2.5 RACEWAY SEALS

- A. Seal all conduit penetrations through fire rated walls, ceilings and floors with a UL classified fire barrier system in accordance with Division 7 Specification Requirements.
- B. Seal all conduit penetrations through airtight spaces and plenums with an approved mastic compound acceptable to the Project Engineer to prevent air leakage.

2.6 PULL BOXES

- A. Provide pull boxes or conduit bodies in accessible locations where required to reduce the number of bends in the conduit run to less than 360 degrees and at points not exceeding 100 feet in long branch circuit conduit runs.

1. Indicate exact location of pull boxes and conduit bodies on the As-Built Record Drawings.

2.7 PULL STRING

- A. Provide a nylon or polypropylene pull string with not less than 200 lb tensile strength in all spare conduits and conduits installed for use by others. Provide a hard cardboard tag for each raceway to indicate location of the opposite end of the raceway.

PART 3 - EXECUTION

3.1 SUPPORTS

- A. Securely support all raceways with full (2 hole) pipe straps, hangers, or ceiling trapeze directly from building structure such as roof trusses, beams, floor joists, etc., in accordance with Specification Section 16190 - Supporting Devices.

1. Do not support raceways from other electrical systems or mechanical systems.

- B. Provide supports at 5'-0" on center with a minimum of two supports for each ten foot length of conduit or fraction thereof up to 6 feet.

- C. Provide a support within 12" of each coupling, fitting, box, enclosure and bend.

1. Install supports at vertical to horizontal conduit bends on the upper side of the bend.

- D. Provide support method for parallel conduit runs as follows:

<u>No. of Conduits</u>	<u>3/4" to 1-1/4" Conduits</u>	<u>1-1/2" and larger Conduit</u>
2	Full Strap, Clamp or Hanger	Mounting Channel
3 or More	Mounting Channel (Trapeze)	Mounting Channel

3.2 INSTALLATION

- A. Raceway layouts on the drawings are generally diagrammatic and the exact routing of raceways will be governed by structural conditions and the work of other contractors.

- B. Install raceways concealed within finished ceilings, walls and floors except where exposed raceways are specifically shown on the drawings or permitted by the Project Engineer.

- C. Install exposed raceways parallel with or perpendicular to walls and ceilings, with right angle turns consisting of symmetrical bends or conduit bodies equal to Crouse-Hinds "Condulet". Avoid all bends and offsets where possible.

1. Paint exposed raceways to match surrounding surfaces in accordance with Division 9 Specification Sections.

- D. Install raceways minimum 12" from insulation of hot water piping, steam piping and other systems or equipment with temperatures in excess of 104° F (40° C).

- E. Make all field bends and offsets with a radius not less than allowed by the National Electrical Code for the type of raceway system.
 - 1. Do not install bends or offsets which are flattened, kinked, rippled or which destroy the smooth internal bore or surface of the conduit.
- F. Cap the open ends of raceways during construction to prevent the accumulation of water, dirt or concrete in the raceways. Thoroughly clean raceways in which water or other foreign matter has been permitted to accumulate or replace the raceway where such accumulation cannot be removed by a method approved by the Project Engineer and/or Engineer.
- G. Install raceways for parallel feeder conductors with the same physical characteristics and in exactly the same manner. Maintain spacing between raceways for entire run.
- H. Do not install raceways which have been crushed or deformed in any manner.
- I. Do not install wiring until work which might cause damage to the wires or raceways has been completed.

END OF SECTION 16110

SECTION 16120 - CONDUCTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide all conductors for power as shown on drawings and as specified herein.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Provide Copper building wire, minimum #12 AWG, with type THHN/THWN or XHHW 600 volt insulation, except as otherwise noted on the drawings or required by NEC.
- B. Provide stranded conductors for wires #8 AWG and larger and for terminal connections to all motors. Stranded or solid conductors may be used for sizes smaller than #8 AWG at the contractor's option.
- C. Provide conductors with surface printed identification showing conductor size and material, insulation type, voltage rating and approvals at regularly spaced intervals of 24".
- D. Do not use sizes smaller than #12 AWG in branch circuits carrying load. Circuits requiring larger sizes to meet voltage drop conditions, etc., are indicated on the drawings.
 - 1. Where branch circuit homeruns indicate conductor size, use that size conductor for the entire branch circuit, including switch legs, etc.
- E. Do not use aluminum conductors.

2.2 SPLICES

- A. Provide Ideal wirenuts or Scotchlock spring connectors for all conductor splices #8 AWG and smaller. Provide split-bolt or compression type connectors for all conductor splices larger than #8 AWG.
- B. Provide splices which are UL listed for the type, quantity and size of the conductors to be spliced.
- C. Provide all splices with insulation at least equal to that of the conductor.
- D. Provide watertight splices in junction or outlet boxes located outside and in wet locations. Provide heat shrink insulating kits or use connectors pre-potted with an

approved waterproof compound.

- E. Splice conductors only in approved boxes. Do not splice conductors in conduit bodies.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all conductors in approved raceway systems.
- B. Install conductors continuous without splice between outlet boxes, devices and panelboards.
 - 1. Provide suitable junction boxes in readily accessible locations where splices are necessary at intermediate points. Indicate exact location of all boxes on the As-Built Record Drawings.
- C. Cut parallel feeder conductors to exactly the same length for each phase, neutral and ground prior to installing the conductors.
 - 1. Install all phase conductors, neutral conductor and ground conductor in each conduit of parallel feeders.
 - 2. Terminate each conductor of each phase, neutral and ground in exactly the same manner including type of connector and torque tightening of the connectors. Provide multi-conductor lugs for conductor termination where possible, suitable for the quantity and size of conductors.
- D. Do not install wiring until work which might cause damage to the wires has been completed.

3.2 COLOR CODING

- A. Color code all wiring at each enclosure and box where conductors are accessible and at each splice, tap or termination by means of colored conductor insulation.
 - 1. For conductors #6 AWG and larger, colored self-adhesive tape with the appropriate color designations may be used.
- B. Color code each conductor of each circuit as follows.
 - 1. Ground: Green or Bare Copper
 - 2. 120/208 Volt, 3 Phase, 4 Wire System
 - a. Phase A - Black
 - b. Phase B - Red
 - c. Phase C - Blue
 - d. Neutral - White
 - 3. 277/480 Volt, 3 Phase, 4 Wire System
 - a. Phase A - Brown

- b. Phase B - Yellow
- c. Phase C - Violet
- d. Neutral - Gray

- 4. Match existing building conductor color coding if different than above.

3.3 MULTI-WIRE BRANCH CIRCUITS

- A. Where a common neutral is run for multi-wire branch circuits, connect phase conductors to separate phases such that the neutral conductor will carry only the unbalanced current. Use neutral conductors of the same size as the phase conductors unless specifically noted otherwise.
- B. Do not install more than three phase conductors in any raceway except where specifically shown on the drawings or approved by the Project Engineer.

3.4 PHASE ROTATION

- A. Phase rotation for Three Phase System will be A leads B Leads C from front to back, from left to right or from top to bottom as viewed from the front of the enclosure.

END OF SECTION 16120

SECTION 16130 - ELECTRICAL BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide junction boxes and outlet boxes at each outlet and device location as shown on drawings and as specified herein.

PART 2 - PRODUCTS

2.1 OUTLET AND DEVICE BOXES

- A. Provide galvanized or cadmium plated sheet steel electrical boxes in indoor dry locations, of the most suitable size and shape for the conditions encountered and in accordance with NEC requirements for the number of conductors allowed.
- B. Provide minimum 4" Square or Octagonal, 1-1/2" Deep Boxes unless specifically indicated otherwise on the drawings.
 - 1. Provide minimum 4" Square or Octagonal, 2-1/8" Deep Boxes where Three (3) conduit connections are required.
 - 2. Provide minimum 4-11/16" Square, 2-1/8" Deep Boxes where Four (4) or more conduit connections are required.
 - 3. Provide gang boxes where more than one device is located at the same point.
 - 4. Boxes smaller than 4" Square or Octagonal, even though of equivalent cubic inch capacity, are not acceptable.
- C. Provide Type FD cast metal boxes outside, in wet, humid or corrosive locations and where exposed to damage such as vehicular traffic.
- D. Confer with the various equipment suppliers and either use or properly provide for boxes which are furnished with the equipment, such as speakers, horns, bells, etc..
- E. Do not use "THRU-THE-WALL" boxes, sectional (gangable) boxes or non-metallic boxes.

2.2 JUNCTION BOXES

- A. Provide junction boxes as specified for outlet and device boxes except that boxes 6" square and larger may be painted sheet steel.

2.3 BOX ACCESSORIES

- A. Provide fittings, plaster rings, cover plates and other accessories suitable for the purpose and location of each box.
- B. Provide plaster rings which are minimum 1/8" deeper than wall covering for flush mounted boxes (i.e. use 3/4" plaster ring for 5/8" gypsum board wall covering) such that plaster ring will be flush with finished face of wall.
- C. Provide industrial raised covers for surface mounted outlet and device boxes.

PART 3 - EXECUTION

3.1 SUPPORTS

- A. Support each box from the building structure independent of the raceway system.
- B. Support flush mounted wall boxes with metal bar hangers or metal stud backing behind the box secured to wall studs.
- C. Support flush mounted ceiling boxes with metal bar hangers secured to ceiling support system or threaded rod hangers secured to structure.
- D. Secure surface mounted boxes to building structure with minimum of 2 screws or bolts as required.
- E. Do not use side mounted boxes or brackets.

3.2 INSTALLATION

- A. Install flush mounted boxes, after being equipped with extensions, accessories, etc., flush with finished face of wall, ceiling or floor.
 - 1. Replace or repair all boxes not installed flush with finished surfaces to the satisfaction of the Project Engineer.
 - 2. In order to meet this requirement, it is recommended that the Electrical Contractor be present during installation of gypsum board, tile or other wall coverings and during installation of outlet boxes in masonry walls.
 - 3. Coordinate depth of wall coverings to be installed on all walls with the General Contractor prior to installing plaster rings.
- B. Seal around the surface of all switch and outlet boxes with plaster or grout to close any opening between the outlet box and the wall finish.
- C. Install boxes level and plumb.

3.3 LOCATIONS

- A. The wiring system layouts on the drawings are generally diagrammatic and the location

of outlets and equipment are approximate.

- B. Study all available drawing details, shop drawings, equipment drawings, building conditions and materials surrounding each outlet and device box prior to installing the box to ascertain the exact location required for each box.
- C. Rough in the electrical work such that electrical outlets, fixtures and other fittings are properly fitted to the work of other trades.
- D. Do not install boxes inside cupboards, behind drawers, or otherwise so located, as to be inaccessible or unsuited for the purpose intended.
- E. The right is reserved to make any reasonable change in the location of the outlets before roughing in, without involving additional expense.

3.4 MOUNTING HEIGHT

- A. Install outlet and device boxes at the heights shown on the drawings or as directed by the Project Engineer. In general, mount outlets as follows.

1. Convenience Outlet	18"
2. Wall Switch	46"
3. Fire Alarm Pull Station	46"
4. Fire Alarm Horn/Strobe	84"
5. Exit Lights	8'-0"
6. Leak detection warning strobe	8'-0"
7. Leak detection warning horn	8'-0"
- B. All mounting heights, including mounting heights indicated on drawings, are to the center of the outlet box above finished floor or grade unless noted otherwise.
- C. Refer to applicable Specification Sections for mounting heights of devices and equipment not included above or install at heights as directed by the Project Engineer and/or Engineer.

END OF SECTION 16130

SECTION 16190 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide suitable supporting devices for all electrical equipment, raceways and components as specified herein and as shown on the drawings.
- B. Refer to individual specification sections for additional supporting requirements.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Provide support anchors which will support in tension a minimum of 4 times the weight of the equipment to be supported but not less 100 lbs.
- B. Provide wood screws in wood; toggle bolts in hollow masonry units; expansion bolts with lead shield or shot anchors in concrete and brick; and machine screws, threaded 'C' clamps or spring-tension clamps on steel work.
- C. Do not use tie wire for support unless specifically called for in individual specification sections.
- D. Do not use threaded C Clamps on tapered steel sections.
- E. Do not weld supports, equipment, boxes, raceways, etc., to steel structures.
- F. Do not use wooden plug inserts as a base for supports.
- G. Do not use shot anchors or drilled anchors of any kind in prestressed or post-tensioned concrete slabs and beams except as approved in writing by the Project Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Secure supporting devices to building structure.
- B. Do not install supporting devices with sheetrock or plaster as the sole means of support. Provide proper blocking behind the sheetrock or plaster as required to support equipment.

END OF SECTION 16190

SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide identification of all electrical equipment, devices, enclosures, conductors, cables, etc., as shown on the drawings and as specified herein.
- B. Refer to individual specification sections for additional identification requirements.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Provide engraved laminated micarta or plastic nameplates to identify each panelboard, cabinet, motor starter, disconnect, etc., with the following minimum lettering heights:
 - 1. Disconnects, motor starters, etc. - 1/4"
 - 2. Emergency control stations, control panels, etc. - 1/4"
- B. Provide Black Nameplates with White Lettering unless noted otherwise, or required to contrast with equipment enclosures.
 - 1. Provide Red nameplates with White lettering for emergency control equipment and devices.
- C. Do not use Dynamo Labels, printed labels, etc., unless specifically called for in other specification sections or approved by the Project Engineer.

2.2 EQUIPMENT IDENTIFICATION

- A. Provide engraved nameplates on the exterior of each Motor Starter, Safety Switch, etc., to include the Equipment Description, Number or Designation, Voltage, Motor Horsepower and/or Full Load Amps and the Circuit from which the equipment is served.
 - 1. Example: FAN COIL UNIT FCU-1
1-1/2 HP, 480 VOLT, 3Ø
CIRCUIT MDP-5
 - 2. Coordinate equipment numbers and designations with the Owner and/or Project Engineer to be consistent with existing equipment numbers and designations.
- B. Provide engraved nameplates on the exterior of feeder and other major junction boxes and pull boxes to indicate the function of the wiring within the box such as "PANEL 'A'

FEEDER" or "FIRE ALARM PULLBOX".

2.3 PANELBOARD IDENTIFICATION

- A. Provide new nameplates on each new Branch Breaker installed in existing Distribution Panelboards to indicate the equipment served by the Branch Breaker and the location of the Panel or Equipment.
- B. Install the branch breaker nameplates on the wireway cover trim of panelboards. Do not install the nameplates on interchangeable dead-front trims.

2.4 CONDUCTOR IDENTIFICATION

- A. Identify each branch circuit and each feeder conductor at each outlet box, pull box or other accessible location with hand lettering in black India ink in the enclosure to indicate panel and circuit numbers of all conductors in the enclosure.
- B. Identify individual control circuit conductors at each termination and in each outlet box, pull box or other accessible location according to the circuit number with self adhesive printed markers equal to Thomas & Betts "E-Z Code" markers.

2.5 PANELBOARD CIRCUIT INDEX

- A. Provide a new neatly typed index to include type of load served and the specific location of the load for each branch circuit of each existing panelboard in which branch circuits are added and/or deleted to reflect the changes in circuiting.
- B. Examples
 - 1. Lighting, Southwest Conference Room
 - 2. Lighting, 2nd Floor Conf. Rm and Office 208
 - 3. Outlets, SW Conf. Rm, west and north walls
- C. Do not use room numbers shown on plans, use room numbers or nomenclature assigned to rooms by the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install nameplates to be visible from normal viewing angles.
- B. Attach nameplates to equipment enclosures with stainless steel screws or rivets. Adhesives are not acceptable.
- C. Install panel index behind protective plastic covering.

END OF SECTION 16195

SECTION 16400 - SECONDARY SERVICE AND DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide electrical service additions as shown on drawings and as specified herein.

PART 2 - PRODUCTS

2.1 SYSTEM

- A. The Existing Secondary Electrical Distribution System is 277/480 Volt, Three Phase, Four Wire, 60 Cycle for HID Lighting, Fluorescent Lighting, and Equipment; and 120/208 Volt, Three Phase, Four Wire, 60 Cycle for Incandescent Lighting, Appliances and Outlets.

2.2 FEEDERS

- A. Sizes and connection of feeders are shown on the Power Riser Diagram. Feeders are sized to handle rated loads and to meet voltage drop conditions.
- B. Do not install conductors of different sizes or types in the same conduits.

PART 3 - EXECUTION

3.1 FEEDERS

- A. Before or during final job site observation, check each panel feeder and main feeder for balance of load on each phase, and make necessary adjustments to insure acceptable balance.

3.2 POWER OUTAGES

- A. Power outages to any portion of the existing buildings will not be allowed except on weekends, holidays and/or as directed by the Owner.
 - 1. Submit written requests for power outages to Salt Lake Community College Facilities Project Manager not less than Seven (7) working days prior to all proposed outages.
 - 2. Do not take any power outages without written permission from Salt Lake Community College Facilities.

* END OF SECTION 16400 *

SECTION 16450 - SECONDARY GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Ground all non-current carrying metallic parts of electrical equipment, raceway systems and the neutral conductor of the wiring system as shown on the drawings and specified herein.

PART 2 - PRODUCTS

2.1 GROUND CONNECTIONS

- A. Make ground connections to the existing building ground system and extend to new electrical equipment, raceways, outlets, lighting, etc..
- B. Bond the neutral conductor to electrical service ground system at the main transformer and the main service equipment only.
- C. Bond all interior metallic piping systems to the electrical service ground system.
- D. Make above ground connections by means of pressure connectors, compression connectors, clamps or other means which are UL Listed and classified as suitable for purpose.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Leave ground connections accessible for inspection.
- B. Connect grounding conductors for grounding receptacles, etc., to a ground terminal in the panelboard. Provide a separate ground terminal for each grounding conductor as it is brought into the panelboard.
- C. Install all grounding in accordance with the latest edition of the National Electrical Code.

* END OF SECTION 16450 *

SECTION 16470 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide new branch circuit breakers in existing panelboards to serve new branch circuits as shown on drawings.

1.3 SUBMITTALS

- A. Provide shop drawing submittals for each type of circuit breaker type in accordance with Division 1 Specifications and Section 16000 - General Provision, Electrical to verify compliance with the Contract Documents.
- B. Clearly indicate voltage, ampacities, interrupting ratings, options, accessories, etc., for each breaker type.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

- A. Provide thermal-magnetic type circuit breakers unless noted otherwise.
- B. Provide multi-pole breakers with trip elements in each pole and common trip handle.
- C. Provide "HACR" rated circuit breakers to serve heating, ventilating and air conditioning equipment branch circuits.
- D. Provide "SWD" rated circuit breakers to serve all lighting and outlet branch circuits.
- E. Provide new circuit breakers in existing panelboards of the same type and interrupting ratings as the existing circuit breakers. Provide new mounting hardware, connectors, dead front covers, etc., as required to install the new circuit breakers.
- F. Plug-in breakers are not acceptable.

2.2 INTERRUPTING RATING

- A. Provide circuit breakers with minimum short circuit current interrupting ratings as shown on the drawings.
- B. The interrupting rating of circuit breakers shall be at least equal to the available short circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short circuit current rating specified for the panelboards.

2.3 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer to match existing Cutler Hammer electrical equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install new circuit breakers in accordance with the manufacturer's instructions.

3.2 IDENTIFICATION

- A. Provide nameplates and neatly typed circuit index for existing panelboards and switchboards in accordance with Section 16195 - Electrical Identification.

END OF SECTION 16470

SECTION 16480 - MOTOR STARTERS AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide motor starters, pushbutton stations, and other necessary operating devices for all Motors and Equipment as shown on the drawings and as specified herein.
- B. Thermostats and similar control devices and control wiring for control of heating, ventilating and air conditioning equipment will be furnished and installed by the Controls Contractor under the provisions of Division 15 Specifications.

1.3 SUBMITTALS

- A. Provide shop drawing submittals for each Motor Starter in accordance with Division 1 Specifications and Section 16000 - General Provision, Electrical to verify compliance with the Contract Documents.
- B. Include Manufacturer's standard published literature for each starter type. Clearly indicate all sizes, ratings, control devices, options, accessories, finishes, etc., to be provided with each starter.
- C. Include typical control wiring diagram for starters provided with accessories such as start-stop pushbuttons, control transformers, pilot lights, etc.. Number terminals and wiring on submittal drawings to match numbering on actual devices.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Unless otherwise noted herein or on the drawings, Motors 1/2 HP and smaller will be Single-Phase rated at 115 or 120 volt. Motors larger than 1/2 HP will be Three-Phase with nameplate rating of 460 volt when used on a 277/480 volt system.

2.2 MANUAL MOTOR STARTERS

- A. Provide Cutler Hammer MS Series single phase manual thermal overload switches with overload heaters for each single phase motor where indicated on drawings.
- B. Provide manual thermal overload switches with pilot light where indicated on drawings.

2.3 MAGNETIC MOTOR STARTERS

- A. Provide Cutler Hammer Freedom Series Class ECN22 combination magnetic motor

starters with adjustable instantaneous trip circuit breaker disconnect of appropriate size and style for each three phase motor where indicated on drawings.

- B. Provide overload relay with three heaters for each starter, sized to accommodate overload heaters rated at 130% of the full load current of the motor which the starter controls. Install overload heaters rated approximately 115% of the motor full load current.
- C. Provide each starter with HAND-OFF-AUTO selector switch coordinated with the automatic temperature control system.
- D. Provide each starter with a Red pilot light to indicate motor operation and a Green pilot light to indicate motor is ready for operation.
- E. Provide each starter with an individual fused control transformer connected such that removal of power to the starter will remove all control voltage from the control circuit.
 - 1. Provide the starter disconnecting means with an electrical interlock or auxiliary contact where required to disconnect interlocking control circuits. Coordinate control and interlocks with the Controls Contractor to maintain this requirement.
- F. Provide each starter disconnecting means for padlocking in the OFF position.

2.4 ENCLOSURES

- A. Provide individually mounted starters with NEMA 1 Enclosures where located in indoor normally dry locations.
- B. Provide individually mounted starters with NEMA 4X enclosures where located in outside or in wet locations. Provide suitable drain for starters located outside in accordance with the manufacturers written instructions.

2.5 HEATER CHARTS

- A. Provide manufacturer's standard chart inside the door of each starter indicating overload heater types, sizes and ratings for the starter.

2.6 ACCEPTABLE MANUFACTURERS

- A. Cutler Hammer to match existing Cutler Hammer electrical equipment.
- B. Provide NEMA Rated, UL Listed starters. IEC Rated starters are not acceptable.

PART 3 - EXECUTION

3.1 SUPPORTS

- A. Provide a minimum of four supports, located at each corner of each enclosure. Where enclosure exceeds 36 inches in any dimension, provide additional supports at 24 inches on center maximum.

3.2 MOUNTING HEIGHT

- A. In general, mount individual motor starters 4'-0" above finished floor or grade to center of starter.

3.3 COORDINATION

- A. Give special attention to wiring and controls for two-speed motors or motors with special controls at no additional cost to the Owner.
- B. Determine exact location of all electrical devices controlling mechanical equipment in cooperation with the Mechanical Contractor in the field before roughing-in.

END OF SECTION 16480

SECTION 16485 VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. Provide new Variable (adjustable) Frequency (speed) drives, including vendor support, for induction motors as shown on the drawings and as specified herein. Applicable to induction motors, single or three phase, fractional to 500 HP.
- B. The VFD installation, harmonic mitigation, and associated equipment coordination and interface shall be provided by a factory trained and certified VFD electrical contractor. Alternately, the electrical contractor may operate under the supervision of an engineer approved VFD/Power Quality Supplier for the installation of the VFD System and associated equipment.

1.3 DEFINITIONS

- A. Total Harmonic Distortion (THD). [Distortion Factor (harmonic factor)]: The ratio of the root-mean-square of the harmonic content to the root-mean-square value of the fundamental quantity, expressed as a percent of the fundamental.
 - 1. $THD = 100 \text{ times the square root of the sum of the squares of all harmonic voltage or current amplitudes, all divided by the amplitude of the fundamental voltage or current.}$
- B. Power Factor - Total:
 - 1. The ratio of the total power input, in watts, to the total volt ampere input to the VFD/ASD.
- C. Power Factor - Displacement:
 - 1. The displacement component of power factor: the ratio of the active power of the fundamental wave, in watts, to the apparent power of the fundamental wave, in volt amperes (including the exciting current of the thyristor converter transformer).
 - 2. The Cosine of the angular difference between the zero crossing of the voltage wave and total current wave.
- D. Telephone Influence Factor (TIF): "For a voltage or current wave in an electric supply circuit, the ratio of the square root of the sum of the squares of the weighted root-mean square values of all the sine-wave components (including alternating current waves both fundamental and harmonic) to the root-mean-square value (unweighted) of the entire wave.
- E. Performance Measurement Point (PMP): The point of connection for performance testing measurements shall be the electrical power input terminals of the VFD on the line side of the filters or phase shifting transformer.

1.4 CODES AND STANDARDS

- A. Provide variable frequency drives which comply the latest edition of the following applicable codes and standards:
- | | | |
|----|--------------------|---|
| 1. | NEC (NFPA 70) | National Electric code, 2002 edition. |
| 2. | ANSI/NEMA ICS 6 | Enclosures for Industrial Controls and Systems. |
| 3. | NEMA AB 1 | Molded Case Circuit Breakers |
| 4. | NEMA ICS 2 | Industrial Control Device, Controllers and Assemblies. |
| 5. | ANSI/UL-508 | Standard for Electric Industrial Control Equipment. |
| 6. | ANSI C37 | Standards for Circuit Breakers, Switchgear, Relays, Substations, and Fuses. |
| 7. | ANSI C57 | Distribution, Power and Regulating Transformers. (Including Reactors.) |
| 8. | IEEE Std. 100-1992 | IEEE Standard Dictionary of Electrical and Electronics Terms. |
| 9. | IEEE Std. 519-1992 | Recommended Practices for Harmonic Control in Electrical Power Systems. |
- a. IEEE Std. 519 is applicable with modifications specified herein.

1.5 SUBMITTALS

- A. Provide submittals for each VFD in accordance with Division 1 Specifications and Section 16000 - General Provisions, Electrical to verify compliance with the Contract Documents and the above referenced standards.
- B. Submit the following information:
1. Description of equipment and tests proposed to meet the power quality requirements of paragraph "Performance Verification Testing", including name and qualifications of the testing service consultant.
 2. Names and qualifications of engineering and technical personnel responsible for installation, start-up, support, and warranty of the VFD systems.
 3. Statement and literature to verify ability of the VFD to directly communicate with the Johnson Controls Metasys system. Include statement from Johnson Controls that software programming is available for the submitted VFD system.
- C. Submit samples of the following compliance and approval forms:
1. Sample of field installation and testing approval form to comply with paragraph "Installation and Start-Up".
 2. Sample of testing approval form to comply with paragraph "Performance Verification Testing".
 3. Sample of training approval form to comply with paragraph "Training".
 4. Manufacturer's quality assurance and factory testing program with samples of certification report forms to comply with paragraph "Source Quality Assurance".
- D. Submit detailed drawings of each VFD to include, but not be limited to, the following;

1. Dimensioned drawings showing accurately the physical size and construction details of the overall cabinets.
 2. Complete dimensioned drawings showing accurately the interior components including spacing between components and wire bending space per NEC.
 3. Electrical ratings of each component to include Maximum Voltage, Maximum Continuous Current, Overload Ratings, Short Circuit Current Interrupting Ratings, Etc..
 4. Schematic wiring diagrams indicating how the equipment is internally and externally connected and interconnected.
- E. Submit performance characteristics of each VFD system indicating in detail how the equipment conforms to the performance requirements of this specification including, but not limited to, harmonics mitigation, power factor, efficiency, voltage rise and radiated energy.

1.6 SOURCE QUALITY ASSURANCE

- A. All material and equipment used in the manufacture of each VFD shall be new and unused. Each component shall be individually UL Listed and Labeled where standards have been established for the component.
1. The fully assembled VFD shall carry a UL label certifying compliance with UL-508 standards. An equivalent safety leveling program by ETL or CSA documenting compliance with these industry standards will be acceptable.
 2. IEC rated devices are not acceptable.
- B. The VFD system manufacturer shall have a quality assurance and testing program to include the following as a minimum:
1. A visual inspection of all system components, wiring connections, and safety mechanisms.
 2. High potential testing on the completed drive including all accessory power components in accordance with UL-508 (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.
 3. A system test run using an actual motor accelerated and decelerated through the entire speed range.
 4. Functional testing of all control panel devices including switches, pilot lights, keypad, programmable functions and other control devices.
- C. Include copies of all factory tests with each VFD for inclusion in the project Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acceptable Variable Frequency Drive system manufacturers, subject to compliance with the contract documents are:
1. ABB Automation Inc.

2. Allen-Bradley
3. Cutler Hammer
4. Magnetek
5. Mitsubishi
6. Siemens
7. Square D
8. Toshiba

B. Submit requests for substitution in accordance the General Conditions and Section 16000 - General Provisions, Electrical and in addition, include the following information:

1. Point by point compliance with the intention of this specification.
2. Actual test and documentation reports from previous projects for all services required for this project.

2.2 LINE INPUT CHARACTERISTICS

A. Refer to drawings for voltages available to operate each VFD. Nominal 60 Hz Line to Line supply voltages encountered may be:

- | | | |
|------------------|------------------|--------|
| 1. Single phase; | 120/208/480 | +/-10% |
| 2. Three phase; | 208/120, 480/277 | +/-10% |

B. Drives shall accept these voltages continuously without damage, deterioration of performance, or life expectancy.

1. Any drive that does not have a standard input voltage within 6% of these line voltage will not be accepted unless the factory warranty is extended in writing by the factory unconditionally for 5 years.
 - a. The 5 year warranty does not exempt the vendor from any other or all other line input characteristics.
2. Drives with factory standard input voltages of 460 V +/-10% continuous duty will not be required to have the extended warranty when used on a 480 Volt System.

C. Line frequency will be 60 Hz +/- 1%

D. Total power factor reflected into the line shall be greater than 95% at all loads and drive speeds. The power factor shall never be unity (100%), but may go leading if the voltage rise is not greater than 5% of the nominal line voltage and never exceeds the line tolerance limits.

1. Total power factor shall be as defined herein at the VFD input terminals. (For reference, this is measured as the ratio of the total power input, in watts, to the total volt-ampere input: i.e. the phase shift between the RMS Line Voltage and the total RMS Current drawn from the line at the drive input terminals. Zero crossing reference is not acceptable.
 - a. Line Current shall include all harmonics present in the current drawn by the drive. The phase shift from the Line Voltage to all current harmonics shall be

included as contributing to the power factor.

2. Energy metering may be by various types of meters which may or may not see all harmonics in their measurement of energy, reactive energy, and related parameters. These meters may be electro-mechanical or electronic. The Power factor of the proposed drive shall not be lower or higher than values specified or for any meter in use on the commercial market.
 3. Any voltage rise or drop from any method of harmonic reduction or power factor correction shall be less than 5% of the measured nominal voltage without the VFD connected.
- E. Total harmonic distortion of the drawn line current at the drive input terminals shall not exceed 12% at all loads and frequencies (speeds).
1. I_{sc}/I_L greater than 50 shall not be applicable under this specification, while <20 may be when appropriate calculations are provided in accordance with IEEE Standard 519.
 2. To achieve the minimum distortion level the manufacturer shall incorporate multiple phase rectification (12 or 18 pulse), L or T filters tuned to the 5th and 7th harmonics, active or passive filters, or other methods. All methods shall have a provisions (such as a series inductor or 12/18 pulse phase shifting transformer in the line side of the filter) to prevent harmonics present on the existing line from external sources from reaching and affecting or damaging the filter, drive etc.
 3. It is recommended that the drive incorporate inductors and capacitors on the DC buss for limiting inrush and steady state rectifier currents.
 4. Where 12 or 18 pulse multiple phase rectification is employed, each drive shall have its own transformer. A single transformer for multiple drives is not acceptable.
 - a. Each phase of a multiple phase rectification phase shifting transformer shall be balanced within $\pm 1.5\%$ of the average line current. Transformer winding phase shift, output voltage and impedance shall fall within this range of deviation.
- F. Total harmonic distortion of the line voltage at the drive input terminals shall not exceed 3% at all loads and frequencies (speeds).
- G. Efficiency shall exceed 95% at all loads and frequencies (speeds).
- H. The above requirements shall apply to common mode and transverse mode.
- I. As applicable to radiated energy, FCC part 15 applies without any exemption for industrial or commercial equipment.
1. Any radiation causing interference with any other equipment or if just detected above limits will be grounds for removal and replacement with a compliant drive without additional cost to the Owner.

- J. Line disturbances such as "notching" from other devices, harmonic distortion of line voltage from external sources, RF and other line disturbances shall not affect the drive performance.
- K. Power source characteristics are indicated on the drawings, to be verified by actual inspection.

2.3 LOAD CHARACTERISTICS

- A. Refer to Drawings for Loads to be connected to the VFD. Loads may be either single phase or three phase induction motors from fractional to 500 Hp. Wound Rotor, Synchronous or DC motors will not be connected to VFDs.
 - 1. VFD driven motors may be operating, but not limited to, air movement devices such as centrifugal fans, axial propeller fans or fluid pumps, etc. If not specified the drive shall operate any motor load. The NEMA torque characteristic of the motor will be specified or determined by inspection or from the manufacture of the operated equipment.
 - 2. Torque characteristics will vary with the motor and application according to NEMA MG 1-1987, design A, B, C, or D. If not specified or other wise determined, the drive shall be capable of operating any motor with any of the standard torque characteristics.
- B. Locked rotor motor characteristics may exceed NEC table 430-7(b) code J, or approximately a minimum of 7 times the full load current of the connected motor. If not specified, the drive shall be capable of operating under the highest locked rotor current without damage.
- C. Motor input voltage ratings shall conform to NEMA MG 1-1987, but shall be operable on the line voltages indicated above.
- D. The Drive shall not require that the motor be rated for duty other than a standard induction motor. Motors specifically rated for VFD service shall not be required.

2.4 DRIVE OUTPUT TO LOAD

- A. Drive out put to load shall be Pulse Width Modulation (PWM).
 - 1. Current Source Invertor (CSI), Variable Voltage Invertor (VVI) Etc. are not acceptable.
 - 2. Drives using "Vector" output technology not using feed back from the motor may be given preferential consideration.
- B. Effective voltage output shall be proportional to the frequency of the output (V/Hz) to maintain minimum motor heating and drawn current.
 - 1. Above 60 HZ the output voltage shall remain constant at the 60 Hz value, or setable through internal programming.
 - 2. Voltage to the load shall be Line to Line and at 60 Hz in accordance with NEMA

MG 1-1987 for the motor being driven, ie. 115/200/460 V.

- C. The drive shall be self protected for load faults or overloads. Motor starting Currents shall not trip the protection system unless the duration of the overload exceeds the load time-current characteristic by 100%.
- D. Motor speed sensors, external to the drive, for feedback to the drive are not acceptable.
- E. The drive shall be capable of operating:
 - 1. Without a motor connected.
 - 2. When the motor is rotating at any speed and it is disconnected under no load to full load, no damage to the drive will occur.
 - 3. When the motor is rotating at any speed or direction, under no load to full load and it is connected to the drive, no damage to the drive will occur.
- F. The drive shall be capable of providing "ride through" for:
 - 1. a 6 cycle input power loss.
 - 2. voltage reduction to 60% of line voltage for 10 cycles.
 - 3. plus or minus 5% frequency variation.
 - 4. distorted line voltage up to 7% total harmonic distortion.
- G. Connections to the motor shall be a standard three wire connection according to NEMA MG 1.
- H. Multiple motor loads are not required.
- I. Dynamic braking is not required.
- J. Frequency of the output shall be adjustable from 0.5 to 120 Hz.
- K. The electrical voltage and current to the motor shall be such that the motor temperature rise is no more than 5% above 60 Hz operation temperature when the drive is operating at other than 60 Hz, and in no case above MG 1 para 12.42.1 or 12.43.
- L. Motor noise from the voltage and current to the motor shall be below the audible level of hearing.

2.5 ELECTRICAL CONSTRUCTION

- A. The electrical construction of the drive shall be all solid state except where otherwise indicated.
 - 1. Drive control shall be by solid state microprocessor and memories as required.
- B. Breakers, switches, contactors and similar devices shall be NEMA Rated and UL Listed. IEC rated devices are not acceptable.
- C. The drive solid state component assembly shall be manually by-passable and totally isolatable from the line/load voltages and currents.
 - 1. Total system protection or individual VFD and bypass protection shall be provided.

2. Protection, isolation, bypass circuit breakers and switches may be electro-mechanical devices. Breakers and switches may be automatic or manual as necessary to provide a safe and operable totally isolated and full load capacity by passed system.
 3. Unless otherwise deleted (where necessary by the external system design), the bypass device shall act as an automatic full capacity across the line, overload protected, motor starter with manually operable control.
- D. Protection shall be internal for overloads, line faults, ground faults, line surges, line under/over voltages, over temperature and semiconductor faults.
1. A main disconnect and fault protection device located within the cabinet with an external operator shall disconnect all lines to the VFD from the line, including filters, transformers, inductors and bypass switches. The device may be a circuit breaker, fused switch (any fuse blowing shall operate all poles to provide all line disconnect), or motor circuit protector (MCP) rated at a minimum of 25,000 AIC or as otherwise specified or approved. Manual operation and reset (except for fuses) shall be by a handle on the front of the cabinet door with padlock provisions on the handle.
 2. Motor overload shall be provided in the VFD through an electronic system incorporating instantaneous trip, inverse time trip and current limiting functions. These shall be optimized for the application and shall be adjustable.
 3. The VFD shall have incorporated within the control system under voltage (and loss of voltage) protection, over temperature protection of the VFD (overall and critical components), and loss of a single phase. Any condition indicated shall cause an orderly shutdown and cause the alarm indication and contact to activate.
 - a. Under voltage or loss of voltage shall re-set to start conditions with the return of normal voltage.
- E. Harmonic line filters or other devices to control the line current harmonics and power factor shall be located within the overall drive cabinet on the load side of the input terminals and main disconnect-fault protective device.
- F. Alarms for component failure, overload or from protective devices indicated shall be displayed on a diagnostic indicator and shall operate a single form "C" (spdt) dry electrical contact.
1. The form "C" contact shall be rated at 120 V AC or DC at 5 amps and have all three leads brought to a terminal block rated for 150 VAC and 10 Amps minimum.
- G. The control panel shall contain a means of "hand-off auto" control independent of the control keyboard.
- H. Restart from shutdown from a power failure, under voltage or other protection shutdown, shall occur upon return of line voltage to within operating voltage specifications, and when there is a remote control signal present or the control is in local (hand) control.

- I. Identified terminals shall be provided for line, load, external control, and external alarm connections that are consistent for the conductor sizes to be used and over sized for larger than current carrying capacity to account for line loss to the VFD and the motor.
 - 1. Wire bending and installation space for line/load terminals shall be provided in accordance with the NEC.
 - 2. All internal wiring shall be permanently marked with hot embossed stamping, shrink fit marked tubing or other pre approved marking system.
 - 3. Wiring identification and terminal identification shall be correctly documented on the drawings and in the Operation and Maintenance manual.
- J. Modular construction is required such that replaceable components, circuit board, etc. can be easily replaced in the field by technicians using conventional tools.
 - 1. Assemblies and discreet components shall be mounted on panels that may be removed for major assembly replacement.
 - 2. Mounting of components directly to the enclosure will not be accepted.

2.6 CONTROL

- A. Primary control of the drive shall be accomplished by direct communication with the temperature control system specified in Division 15 Specifications.
 - 1. Provide a serial interface board in the VFD to allow direct communication between the VFD central processing unit and the Johnson Controls Metasys Temperature Control System to allow control, monitoring, and programming of the VFD at the central workstation computer of the temperature control system.
- B. Provide each VFD System with local manual controls and provision for remote control by signals from other vendors or sources.
 - 1. Provisions for remote control signals may include 4 to 20 Ma or 0 to 10 V.
- C. Control voltages for internal systems and indicators shall not exceed 120 VAC.
 - 1. Provide primary and secondary fused control transformers, sized larger than internal loads where external interlocks or other controls are indicated as special items.
- D. Forward and reverse control is not required.
- E. Hand-Off-Auto, local-remote, output frequency (speed) adjustment controls (if other than touch pad), and touch pads parameter settings shall be provided front cabinet accessible without opening the cabinet.
- F. Internal or touch pad parameter adjustments shall be included in the control system:
 - 1. Maximum and minimum speed (output frequency).
 - 2. Acceleration and deceleration times or ramp slope.
 - 3. Maximum motor voltage.

4. A minimum of 3 frequency jumps for avoiding motor resonance.
5. Motor over current trip point.

2.7 METERS, INDICATING DEVICES, INPUT DEVICES AND TOUCH PADS

- A. Metering for output frequency, voltage, and current shall be provided. (This does not indicate to measure the carrier frequency)
 1. Percent of frequency in place of actual frequency is not acceptable.
- B. The above meters shall all be panel mounted on the drive front panel and shall be visible without opening the cabinet.
 1. Provide individual 2.0% accuracy meters for output Frequency, Voltage and Current connected such that meters will operate whether the drive is operating on the VFD or in the bypass mode.
 - a. Provide switching to select the desired phase on three phase drives.
 2. Panel meters shall be labeled as to function and shall indicate it is the load that is being measured...LOAD VOLTAGE.....LOAD CURRENT.....LOAD FREQUENCY.....
 3. Panel RMS voltage and current meter frequency response shall be through the 40th harmonic of 60 Hz (2,400 Hz). Any transducers or CT's shall be of the same response.
- C. Diagnostic meters and indicators may be a single indicating device and shall display any alarms or critical diagnostic information when not under the control of an operator.
- D. Hand-Off-Auto, local-remote, output frequency (speed) adjustment controls, and touch pads shall be industrial type oil tight devices and shall be mounted on the front panel such that they may be operated without opening the door.
- E. Indicating lamps shall be mounted on the front panel and include;
 1. power on.
 2. VFD operating.
 3. VFD fault.
 4. VFD bypassed.

2.8 ENCLOSURE

- A. The Enclosure system shall consist of an external cabinet and internal component or safety closures.
 1. The enclosure shall house all components of the drive including the drive, bypass switching and line filters or transformers.
 2. Internal component closures shall provide a dead front design for all electrical components and open terminals to prevent inadvertent contact with live terminals

or components when the door is open by means of insulating covers over all live terminals and components.

3. The overall external enclosure may be a NEMA 1 Gasketed or NEMA 12 enclosure, not exceeding 80 inches in height, with hinged and locking door.
- B. All front cabinet meters, switches and input devices shall be identified by a screened or engraved labels attached with screws or rivets (glue is not acceptable).
- C. Ventilation may be as required, natural or forced air for system operation in the encountered ambient environment.
 1. For natural or forced air ventilation, a means of maintaining the enclosure integrity shall be provided. Open holes are not acceptable and other types of openings must exclude dripping water and dust.
 2. Heat transfer through the cabinet wall to external cooling fins is acceptable if adequate for cooling under the encountered ambient environment.
- D. The overall cabinet shall have a finish that protects from corrosion.
- E. A padlock locking system shall be provided for the overall cabinet door and may be part of the latching system of the door operating handle in the form of a padlock hasp.
 1. The hasp with padlock shackle inserted shall prevent the handle from operating.
 2. The door handle shall operate a two or three point latching system.
 - a. Special wrenches or tools to open or unlatch the door or cover will not be accepted.

2.9 ENVIRONMENT

- A. The drive shall be rated for 4,500 ft above msl with or without derating.
 1. Where derating is required to achieve the altitude requirement, the de-rated capacity at 4,500 ft msl shall not be less than 125% of zero to full load and at all frequencies (speeds).
 2. Verification of the drive rating in its enclosure at 4,500 ft msl without derating and where derated shall be provided by printed factory specifications.
 3. Any drive not providing this verification shall not be acceptable and shall be rejected without further action.
- B. The VFD shall be capable of operating in an ambient temperature range of 0° C (32° F) to 40° C (104° F).
- C. The VFD shall be capable of operating in a Relative Humidity of 5% to 95% non condensing.

PART 3 - EXECUTION

3.1 SUPPORTS

- A. Provide a minimum of four supports, located at each corner of each drive enclosure. Where enclosure exceeds 36 inches in any dimension, provide additional supports at 24 inches on center maximum.
- B. Provide additional supports for free standing enclosures from top of enclosure to the building structure.

3.2 INSTALLATION AND START-UP

- A. Install each VFD under the direction of a factory trained and authorized representative and in accordance with the manufacturer's written instructions.
 - 1. Verify all installed overload elements, fuses, circuit breakers, wiring, etc., are properly sized for the actual motor and drive.
 - 2. Verify interlock and control wiring is properly installed and the drive is able to be controlled by the building temperature control system.
- B. Each VFD shall be started by a factory trained and authorized service technician.
 - 1. Verify motor rotation is correct in all modes of operation.
 - 2. Verify all operator devices, programming and monitoring function are fully operational.
 - 3. Verify operation of all field signal control connections.
 - 4. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to the motor nameplate rating at full speed. Check full load current measurements against motor nameplate data.
 - 5. Make all parameter adjustments to tune and optimize the drive system to the application. Record all configuration values for inclusion in a report.
- C. Touch-up any scratched or marred surfaces of the drive enclosure with paint supplied by the manufacturer.
- D. Submit to the project engineer a signed copy of the start-up procedure report, certifying proper system operation prior to scheduling Performance Verification Testing.

3.3 PERFORMANCE VERIFICATION TESTING

- A. Conduct performance verification testing of each VFD upon approval of the installation and start-up test report.
 - 1. Provide calibrated test equipment and trained operators to verify compliance with the requirements of paragraph "Line Input Characteristics" for the following

electrical characteristics:

- a. Voltage.
 - b. Line frequency
 - c. Total Power Factor
 - d. Harmonic Distortion
 - e. Efficiency
 - f. Radiated energy
 2. Test equipment shall be calibrated by an independent calibration laboratory with test equipment and procedures as required and traceable to the National Standard Institute (NSTI i.e. NBS).
 - a. A current calibration sticker indicating the date of calibration and the expiration or re-calibration date shall be affixed such that any tampering will destroy the sticker.
 - b. Test equipment shall be capable of measuring accurately through the 35th harmonic (2,100 HZ) and beyond.
- B. Test the VFD line input terminal under the following conditions:
1. Without the VFD connected or bypassed.
 2. With the motor running and driving its normal load with the VFD and filtering bypassed.
 3. With the VFD connected, the motor running and driving its normal load;
 - a. at 50% speed (30 Hz).
 - b. at 75% speed (45 Hz).
 - c. at 100% speed (60 Hz).
- C. Any drive not meeting the requirements of this specification will be repaired or replaced at no additional cost to the Owner.
- D. Submit written test reports to the Project Engineer within 7 calendar days of test completion.
1. Include statement of compliance or description of characteristics which do not comply with the requirements of this specification.
 2. Include graphical and text data of voltages and current wave forms, measured distortion, harmonic levels through the 35th harmonic, transformer derating and telephone influence factor (TIF).
 3. Include description of test equipment used and calibration verification.
- E. Performance Verification Testing may be performed by the VFD Supplier or by and independent testing agency at the option of the Contractor.
1. The Owner reserves the right to engage the services of an independent testing service consultant, to be paid for by the Contractor, should the test reports submitted by the VFD Supplier be incomplete, incorrect, or otherwise unsatisfactory

to the Project Engineer, Electrical Consultant and/or Owner.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance Manuals in accordance with the General Conditions and Division 1 Specifications.
- B. Include manufacturers' catalog and/or descriptive literature of equipment actually installed. Clearly indicate on literature the specific model and/or catalog numbers of equipment installed, including all options, accessories and/or modifications.
- C. Include test reports and results including corrective action taken to comply with the requirements of this specification.
- D. Include complete operating procedures and maintenance procedures.
- E. Include complete certified as built schematics, wiring diagrams, ladder and logic diagrams.
 - 1. Drawings shall be full drawn size and in readable condition.
 - a. Drawings larger than 11" x 17" may be provided as AUTOCAD files on CD.
- F. Include identification of and list of all replaceable parts.
- G. Include periodic service requirements with the service interval.
- H. Provide manuals in a hard back ring binder or the manuals may be included as a separate section of the Electrical Operation and Maintenance Manuals.
 - 1. Drawings larger than 11 by 17 inches shall be folded and stored in pockets in the binder.

3.5 VENDOR SUPPORT

- A. The vendor (supplier) shall demonstrate that local maintenance and spare parts support is available.
 - 1. The vendor shall certify all replaceable parts are available within 24 hours using surface transportation.
 - 2. Replaceable parts available within a 100 mile radius of the Project Site may be indicated in place of 24 hour availability.
 - 3. The parts stocking location address and phone number shall accompany the submittal and be included in the operation and maintenance manuals.
- B. The vendor shall demonstrate and certify that factory trained service technicians are available within a 100 mile radius of the Project Site and that response within 24 hours after a request for assistance is customary.
 - 1. To verify the availability of technician response, the vendor shall provide a directory of customers that can vouch for the response.

3.6 WARRANTY

- A. Provide a 1 Year Warranty for each VFD system in accordance with the General Conditions and Division 1 Specifications to include parts labor and travel expenses from the date of Substantial Completion.
- B. The warranty shall cover each entire VFD system including power devices, controllers, filters, etc., included as part of the system package.
- C. For equipment or components manufactured by other than the complete VFD system manufacturer, which comprises more than 25% of the cost of the VFD system, the original equipment manufacturer shall be identified with the nearest office and warrant obligation.

3.7 TRAINING

- A. Provide the services of competent instructors to instruct the owner's designated operating and maintenance personnel in the operation, maintenance, calibration, configuration, and programming of the VFD systems. Provide a training manual for each person which describes in detail the material included in the training program. Training shall include:
 - 1. System overview
 - 2. General theory of operation
 - 3. System operation
 - 4. System configuration
 - 5. Alarm formats
 - 6. Failure recovery procedures
 - 7. Maintenance and calibration
 - 8. System programming and configuration
- B. Include instruction for between 4 and 6 people of not less than 4 hours nor more than 8 hours which shall include both classroom instruction and actual hands-on training.
- C. Date, time and place of training shall be coordinated with the owner and performed prior to substantial completion.
- D. Verification of training shall be certified in writing on a form acceptable to the owner. Include copies of the form in the operation and maintenance manuals.

3.8 COORDINATION

- A. Determine exact location of all electrical devices controlling mechanical equipment in cooperation with the Mechanical Contractor in the field before roughing-in.

END OF SECTION 16485

SECTION 16720 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions, Supplemental General Conditions, Division 1 Specification Sections and Section 16000 - General Provisions, Electrical apply to work of this section.

1.2 SCOPE

- A. The existing Chiller Building is protected by a complete fire alarm system. Modify and extend the existing fire alarm system as required to coordination with new construction and remodeling.
- B. Provide new initiating devices, notification appliances and other accessories as shown on drawings and as required.

1.3 SUBMITTALS

- A. Provide submittals for the Fire Alarm System in accordance with Division 1 Specifications and Section 16000 - General Provisions, Electrical to verify compliance with the Contract Documents and referenced standards.
- B. Provide manufacturer's standard catalog literature for all new Fire Alarm System Devices.
- C. Provide two copies of the Fire Alarm System Shop Drawing Submittals, in addition to the quantity of submittals required by the General Conditions, for review by the local Authority Having Jurisdiction (AHJ).
 - 1. Approval of the AHJ is required prior to installing any part of the Fire Alarm System.

PART 2 - PRODUCTS

2.1 CONTROL PANEL

- A. Existing Gamewell "Zans 400" main fire alarm control panel is to remain.
 - 1. Provide new zone modules control relays, etc., as required to control new fire alarm system initiating devices, notification appliances and control devices.
 - 2. Modify the main fire alarm control panel programming to properly annunciate and control new fire alarm system devices.
- B. Provide additional power supplies and/or batteries as required to operate the system with additional detectors, notification appliances, fan shut down relays, etc.

2.2 FIRE ALARM DEVICES

- A. Protect existing fire alarm system devices indicated to remain. Remove smoke detector heads during demolition or construction as required to prevent excessive dust accumulation in the detector head. Clean all existing detector head upon completion of the work.

2.03 MANUAL PULL STATIONS

- A. Non coded single action breakglass type, SPST N.O. contacts, die-formed aluminum construction, key reset, keyed to master control panel and semi-flush mounted backbox: Gamewell M46-28.

2.04 HEAT DETECTOR

- A. Combination rate-of-rise and fixed temperature heat detector with 135 degrees F fixed temperature rating.

2.5 NOTIFICATION APPLIANCES

- A. Provide new Notification Appliances which meet the requirements of National Fire Alarm Code - NFPA 72, ANSI 117.1, UL Standard 1971 and ADA-AG 4.28
- B. Provide new Horns to produce minimum 86 dB at 10 feet. Provide new horns to match sound of existing horns in the building.
- C. Provide new flashing strobe lights with lexan lens with the word "FIRE" in red letters and minimum effective candle power ratings as indicated on drawings and a flash rate of between one and two flashes per second.

2.6 FIRE SAFETY FUNCTION CONTROL RELAYS

- A. Provide new control relays with SPDT contacts rated 10 amps at 120 VAC and with 24 VDC coil to control fan shut down, smoke dampers, etc., as shown on the drawings.
- B. Provide fan shut down control relays in separate enclosure adjacent to the starter enclosure, or within the enclosure, of each air supply fan as shown on drawings and connect to a normally closed auxiliary contact in the fire alarm control panel. Connect the fan control circuit to the control relay output contacts so that the air supply fan will shut down upon general fire alarm.

2.7 WIRING

- A. Furnish and install new type THHN copper wire for all fire alarm system wiring of the sizes indicated on the drawings. Install all wiring in approved metal raceway system as specified for power wiring except that minimum 1/2" trade diameter conduit may be used.
- B. Wire shall be #14 AWG, Solid except as required to match existing wiring.
- C. Do not install fire alarm system wiring in raceways with any other wiring systems.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all fire alarm system raceways with separate raceways entering and leaving each outlet box and/or enclosure.
 - 1. Existing fire alarm system initiating device circuits are Class A, Style D loop in accordance with NFPA 72.
 - 2. Existing fire alarm system notification appliance circuits are Class A, Style Z loop in accordance with NFPA 72.
- B. Color code fire alarm system wiring as recommended by the manufacturer to match the existing fire alarm system color coding. Tag all conductors according to zone circuit at all terminals, pull and junction boxes.
- C. Paint all new fire alarm system junction boxes, pull boxes, etc. red with identification of zones served indicated on the device or box.
- D. Supervision of installation, final connections, programming and testing will be provided by a trained factory representative of the existing fire alarm system manufacturer.
 - 1. Contact: Nelson Fire Systems
1481 South Major Street
Salt Lake City, Utah
(801) 468-8300

3.2 SYSTEM OUTAGES

- A. The existing Fire Alarm System will remain completely operational throughout construction except portions may be temporarily taken out of service for reconnections as indicated on the drawings.
 - 1. Submit requests for fire alarm system outages to the SLCC Facilities Project Manager not less than 7 day prior to any proposed fire alarm outages.
 - 2. Immediately notify the SLCC Facilities Project Manager if the fire alarm is unintentionally disabled and immediately make repairs to restore the system to an operational condition.
 - 3. The contractor shall maintain a fire watch during all fire alarm system outages in accordance with IFC Section 901.7.
 - 4. Do not leave any portion of the fire alarm system inoperable longer than is absolutely necessary make reconnections.
 - 5. Provide temporary wiring and/or connections as required to maintain the system in an operable condition.

3.3 RECORD DRAWINGS

- A. Provide new building map for the existing control panel to reflect floor plan changes, new initiating devices locations and new initiating devices address numbering. Mount the building map behind a protective plastic covering.
- B. Update existing fire alarm system record drawing to include locations and wiring of new devices and equipment as installed. Include junction box locations and detector and pull station wiring.

3.4 TESTS

- A. Test the entire fire alarm system in accordance with NFPA 72 requirements to show that all equipment is in proper working order.
 - 1. Tests shall be conducted in the presence of the Owner and/or Engineer and the Authority Having Jurisdiction.
 - 2. Coordinate with Project Engineer to determine time of testing that is acceptable to all parties involved.
- B. Provide two-way radios, canned smoke and a hair dryer (or other means to set off smoke and heat detectors).
- C. Test each new and existing initiating device and open each IDC and NAC circuit to test the Class A loops.
- D. Put the main control panel on battery power not less than 24 Hours prior to Final Inspection. The batteries shall maintain the fire alarm system in supervisory mode for not less 24 Hours and then be able to operate all notification appliances continuously for not less than 10 Minutes.
- E. All devices will be complete and operational.

END OF SECTION 16720